

## **Appendix A**

### **CALSIM II Model Modifications for Integration of Friant Division**

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#### **INTRODUCTION**

The operation of the Friant Division of the Central Valley Project (CVP) historically has not been represented in state-wide water planning models. The Friant Division is hydraulically connected with the San Joaquin River and can affect CVP South-of-Delta operations, particularly during flood events. The releases from Friant Dam to the San Joaquin River, along with an assumed Tulare Lake Basin overflow operation from the Kings River system, occasionally provide a water supply to the Mendota Pool, thereby potentially affecting the delivery of CVP water from the Delta-Mendota Canal, and thus affecting the West-side operation of the CVP and State Water Project (SWP). However, in recognition that Friant Dam has not been specifically operated for this purpose, simulated diversions to the Madera and Friant-Kern Canals have been depicted by regression equations based on historical deliveries. The models also included releases to the San Joaquin River to depict minimum release requirements for downstream riparian and contractor diversions, and flood control releases.

Current forums are investigating Friant Division operations for the potential of enhancing water supplies within the local area and for the benefit of other interests including a state-wide and Federal interest. Those investigations include assumptions for additional facilities, alternative operation plans, and alternative flow regimes below Friant Dam. To evaluate the performance of alternative facilities and plans, the operation of the Friant Division, as depicted in CALSIM II, required modifications. Fundamental to these modifications was the development of logic and assumptions for the existing (benchmark) operation of the Friant Division.

This documentation focuses on the development and implementation of (DEFINE) WRESL code and data assumptions for the benchmark depiction of Friant Division operations for the current level of development and operations.

#### **MODEL PURPOSE AND SUMMARY DESCRIPTION**

The benchmark model provides a tool that can depict current Friant Division water diversions and operations during a long-term simulation period (1922-1994). Canal diversions vary from year to year based on an annually variable water supply. The monthly distribution of an annual allocation is based on historical diversion practices, which are influenced by water delivery requirements and preferences of the contractors. Minimum required releases below Friant Dam for riparian and contractor users are modeled as a

constant annual requirement, consistent with recent records of operations. Flood control operations for Millerton Lake and the lower San Joaquin River are based on the rainflood space reservation requirements specified by the U.S. Army Corps of Engineers (USACE). The flood control operation during the snowmelt runoff period recognizes the competing objectives of water supply and flood control. The operation attempts to maximize water supply carry-over storage (into summer) while reducing the potential for downstream flooding.

### **FIXED BOUNDARY INPUTS AND PARAMETERS**

Several fixed parameters and simulated inputs are included in the benchmark model. These inputs and parameters represent attributes of Friant Division facilities or hydrology that do not vary.

#### **Millerton Lake Area-Capacity-Evaporation**

The Millerton Lake area-capacity relationship is depicted using a lookup table relating area to volume (Table A-1). The table was developed from data shown in the tables included in Report on Reservoir Regulation for Flood Control, Friant Dam and Millerton Lake San Joaquin River, California, Department of the Army, December 1955, Revised August 1980. Area is determined in CASLIM II by interpolating between storage values in the table. Monthly evaporation rates were estimated by DWR and input to CALSIM II as a timeseries.

**TABLE A-1**  
**MILLERTON LAKE AREA-CAPACITY RELATIONSHIPS**

Storage (AF)	Area (Acres)
0	0
60,000	1,205
100,000	1,749
140,000	2,200
190,000	2,685
250,000	3,190
310,000	3,637
380,000	4,103
450,000	4,524
530,000	4,963

#### **Millerton Lake Inflow**

CALSIM II does not currently simulate the operations upstream of Millerton Lake. The benchmark model incorporates operations upstream of Millerton Lake consistent with the “Base Plan” results described in *Evaluation of Potential Increases in Millerton Lake Water Supply Resulting from Changes in Upper San Joaquin River Basin Projects Operation, Phase 2, U. S. Bureau of Reclamation, October 2000*. Input to the benchmark model derived from that study include inflow to Millerton Lake and the monthly storage at Mammoth Pool, as listed in Attachment A.

## Flood Control Constraints and Operations

Flood control is an important aspect of Friant Division operations, and is guided by objectives included in *Report on Reservoir Regulation for Flood Control, Friant Dam and Millerton Lake San Joaquin River, California, Department of the Army, December 1955, Revised August 1980*. At any given time, Millerton Lake storage is within one of three zones: within the conservation space, when flood releases are not required; within the rainflood space, when water stored in this space (including credit for available storage space in Mammoth Pool) will be released as rapidly as possible without exceeding 8,000 cfs below Little Dry Creek, or 6,500 cfs at the Mendota gage; or within the conditional space, when releases are required in excess of irrigation demand, and are determined based on forecasted runoff, available upstream space and forecasted irrigation demand.

The required rainflood space is a fixed end-of-month constraint as identified in the Table A-2. During the heaviest precipitation months of November through January, 170,000 acre-feet of reserved space is maintained. The amount of space required in Millerton Lake (in excess of 85,000 acre-feet) is reduced by the amount of available space in Mammoth Pool. When necessary, CALSIM II logic creates a release to the San Joaquin River that is sufficient to not allow storage to encroach into the required rainflood space. The current version of CALSIM II is based on a monthly time-step and does not calculate instantaneous or peak flow rates. Therefore, the model does not constrain releases in consideration of the downstream flow objectives.

**TABLE A-2**  
**MILLETON LAKE RAINFLOOD SPACE**

Rainflood Space(1,000 acre-feet)*											
Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
85	170	170	170	42	0	0	0	0	0	0	0

\* Space in excess of 85,000 acre-feet can be replaced by an equal amount in Mammoth Pool

During the conditional space time period (modeled February through June), an algorithm is used to simulate the management of flood volumes over the entire period. The release necessary to operate within the conditional flood control space is determined for each month between February and May. This is done by making a forecast of the quantity of water anticipated to be spilled by the end of June. The forecast requires an estimate of the available water supply, project deliveries, lake evaporation and minimum river releases through the end of June. The water supply forecast uses perfect foresight to predict the amount of Millerton inflow that will occur through the end of June. The deliveries, evaporation and minimum river releases through the end of June are estimated. Using the water supply forecast, delivery forecast, current storage, and end of June full reservoir storage target (520,000 acre-feet), the projected volume of spill through the end of June is computed. The projected spill volume is then distributed on a release schedule, which is consistent with historical reservoir flood control operation. Large projected spills are spread out over several months to surrogate the avoidance of large flows late in the season, while the release of small

projected spill volumes is deferred until their release is necessary in May or June. The flood control release made for a given month is the greater of the computed rainflood release or the conditional space release.

The management (shaping) of river releases for operation within the conditional space is determined by user input matrices that establish river releases based on the forecast of spill volumes. A different matrix is used for each month of forecast from February through May. The matrix for a subsequent month only differs from the previous month's matrix by the amount of volume that is determined to be passed during the previous month. The algorithm is not operative during June as it is assumed that Millerton Lake has an objective to fill by the end of June, and any required spill in excess of minimum releases will be determined by the balance of operations during the month. Attachment A.2 shows the matrices for each month of forecasted operations.

### **Minimum Downstream Releases**

Other than flood control releases, the release from Friant Dam to the San Joaquin River is limited to that amount necessary to maintain diversions by riparian and contractor users below Friant Dam at a location near Gravely Ford. Water diverted to the fish hatchery below Friant Dam and returned to the river partially serves that purpose. Review of historical operation records provided guidance in estimating the minimum downstream release used for the benchmark model. Attachment A.3 shows the historical record of release from Friant Dam to the river, inclusive of flood releases. From an analysis of the record (1990-1994) for periods when no flood control releases were made, an annual release of 116,700 acre-feet was estimated to be the current minimum release necessary to meet downstream diversions (including seepage). Table A-3 illustrates the assumed monthly distribution of this release requirement.

**TABLE A-3**

#### **ESTABLISHED MINIMUM RIVER RELEASE REQUIREMENTS FROM MILLERTON LAKE**

<b>Estimated Minimum River Release Requirement from Millerton Lake (1,000 acre-feet)</b>											
Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10.1	7.4	6.7	4.5	5.0	6.6	9.0	10.9	12.9	14.4	15.7	13.4
Total: 116,700 acre-feet											

### **FRIANT DIVISION CANAL DIVERSIONS**

Modeling canal diversions that are dependent on land use-based water demands is currently beyond the scope of this work effort. That effort will require significant additional analyses that concern the operation of other water resource supplies within the Tulare Lake Basin. At this time, the water diversions developed for the benchmark model mimic recent historical operations.

## **Delivery Patterns**

A review of the historical record of water deliveries from the Friant Division was conducted. The record of those deliveries is contained in a database maintained by Reclamation. The protocol of the database attempts to categorize the different classifications of water deliveries made through the Friant Division. The review found several anomalies within the data, some of which could be explained by changing practices of classification (or institutional changes in classifications) and others that were apparently data entry errors or multiple accountings. Although questionable or possibly misinterpreted data were a problem, the review provided significant insight regarding the relationship between water supply availability and water delivery patterns for the Friant Division.

Most salient to this analysis are the data concerning monthly deliveries from the Friant-Kern Canal and the Madera Canal as water supply availability changes during a year. The data and analysis allowed development of a water delivery function based on water supply availability at Millerton Lake that is responsive to both flood control operations and other considerations within the basin that affect the delivery of water from the Friant Division, such as water availability from tributaries within the Tulare Lake Basin. Analysis also provided a coarse division of water deliveries between Class 1, Class 2, and other water classifications.

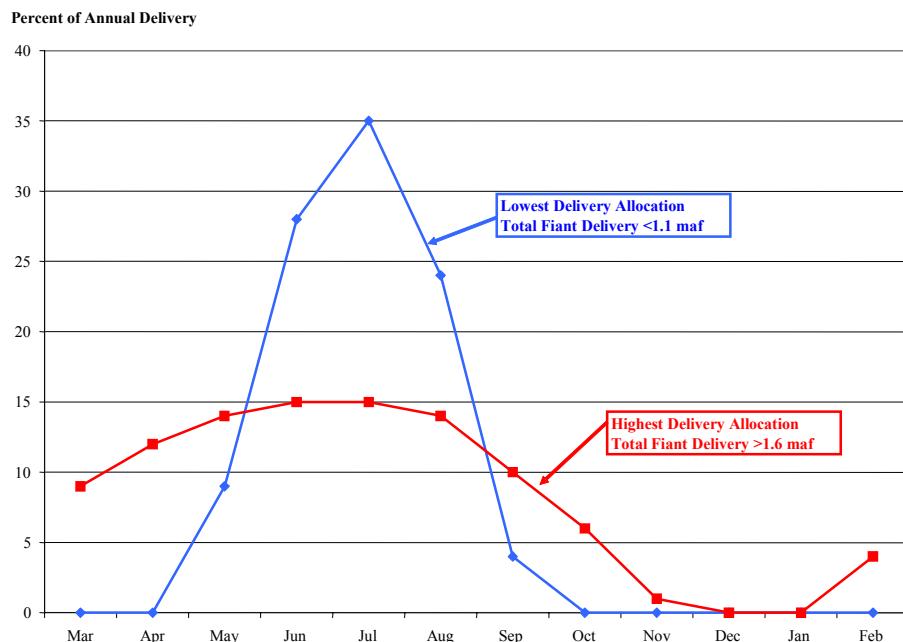
Tables A.4-1 and A.4-2 of Attachment A.4 list various components of historical recorded water deliveries from the Friant-Kern Canal. Tables A.4-3 and A.4-4 list the same components for water deliveries from the Madera Canal. Three components of deliveries are listed: "Class 1", "Class 2", and "Other". The reported Class 1 and Class 2 components are considered to be reasonably accurate and are acceptable for the purpose they are used in this planning-level model; however, as described earlier the database from which the values were derived contain occasional discrepancies with other records of deliveries. The record as presented in this documentation should not be used as the final statement of deliveries. Deliveries listed as "Other" were not quantitatively used in this analysis except as an indication of months when water other than Class 1 and Class 2 appeared to be delivered.

Figure A.4-1 of Attachment A.4 graphically illustrates the monthly delivery of water, as a percentage of total annual delivery, for both the Friant-Kern Canal and the Madera Canal. A depiction of Class 1 and total water deliveries is shown for each canal. There is substantial variability in the monthly distribution year-to-year. Analysis shows that definite trends occur between the total availability of water to Friant Division contractors and the pattern in which they take deliveries. Most significantly affecting the pattern is the availability of Class 2 water. The availability of Class 2 water proportionately concentrates deliveries during the spring-time and also affects the pattern that Class 1 deliveries are made to contractors that have both Class 1 and Class 2 supplies. During years with Class 2 water available, contractors with both Class 1 and Class 2 supplies will tend to shift their delivery of Class 1 supplies to later in the year, thus extending the period of deliveries.

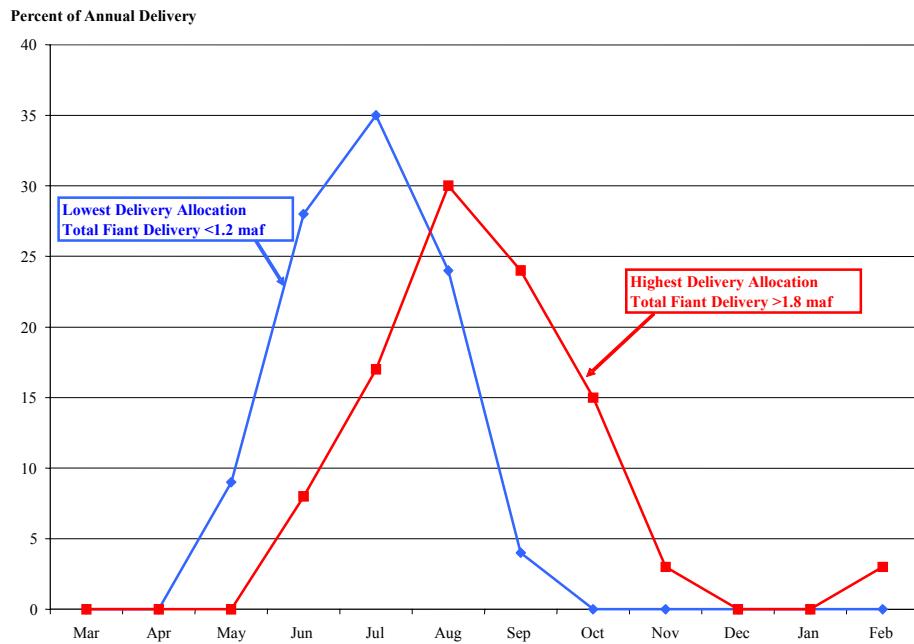
The model's water delivery function distributes a forecasted volume of water supply into monthly deliveries to the Friant-Kern and Madera canals. Key to this distribution is the relationship between monthly deliveries and water supply availability. The model determines a forecasted volume of water availability. With that determination, the pattern of total water deliveries and the pattern of Class 1 deliveries are established. The product of the

pattern and the water supply (limited by contract maximums) results in the monthly delivery of water. Inferred by the difference between the total delivery and the Class 1 delivery is Class 2 delivery.

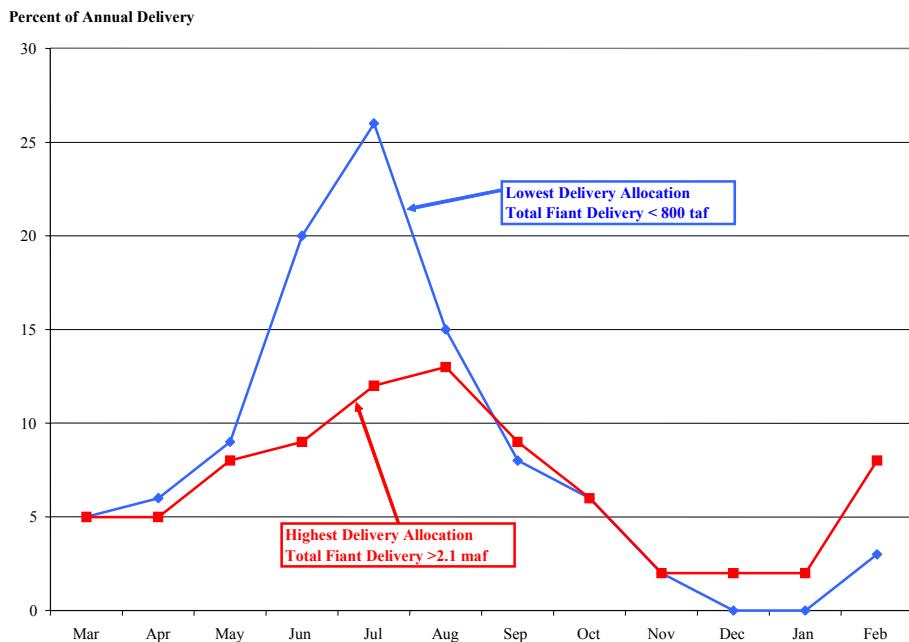
From the many years of record, certain years of data were selected to develop guidance for establishing a water availability/delivery distribution pattern relationship. Years during which only Class 1 water was available provided an indication of the delivery pattern associated with limited water supplies, those years when no Class 2 supply was available. The pattern is used to distribute a water supply that equals or is less than 800,000 acre-feet (a full Class 1 supply). A second group of years was selected to represent the delivery patterns of Class 1 and total deliveries during years when the available water supply was near full Class 1 and Class 2 allocations without exceeding a full Class 2 allocation (years when “Other” water may influence the delivery of Class 2 deliveries). Intermediate patterns between these two bounds of patterns were established to transition from the availability of only Class 1 supplies to the availability of full Class 1 and Class 2 supplies. Figures A-1 through A-4 illustrate the range of patterns used to distribute deliveries from the canals.



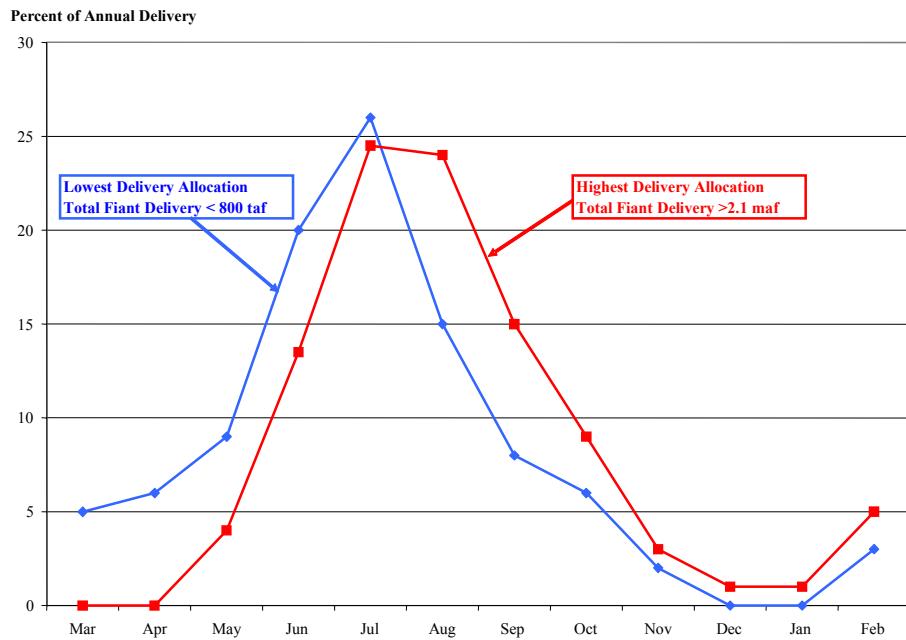
**FIGURE A-1. MADERA CANAL TOTAL DELIVERY PATTERN**



**FIGURE A-2. MADERA CANAL CLASS 1 DELIVERY PATTERN**



**FIGURE A-3. FRIANT-KERN CANAL TOTAL DELIVERY PATTERN**

**FIGURE A-4. FRIANT-KERN CANAL CLASS 1 DELIVERY PATTERN**

### Delivery Adjustments

Two adjustments are made to deliveries after initial allocations are made with the delivery logic. One is based on wetness in the Tulare Lake Basin and the other is based on flood control releases from Friant. Deliveries from the Friant-Kern canal are reduced when there is abundant surplus in the Tulare Lake Basin tributaries. This is a surrogate of the reduction in deliveries that occurs when Tulare Lake Basin water users are receiving flood flows from their local tributary projects. Conversely, deliveries to both the Friant-Kern and Madera Canals are increased when spills from Friant can be delivered. The model assumes an increased demand for water when Friant is spilling. The demand for surplus is a user-defined input to the model. The increased flood flow demand logic will not occur during months when the Tulare Lake Basin tributary logic reduces deliveries.

### Canal Losses

Added to the synthesized water deliveries are canal losses that were developed through a comparison of historical water deliveries and canal diversions. Using the same selective analytical process of evaluating certain years and months of diversion and delivery data, an estimate of monthly un-accounted for diversions (losses) was developed. When modeled as being in operation (a diversion is occurring), the losses become an additional diversion requirement of the Madera and Friant-Kern Canals. The estimated canal losses are shown in Table A-4.

**TABLE A-4**

**ESTIMATED CANAL LOSSES**

Estimated Friant-Kern Canal Losses (1,000 acre-feet)											
Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
5	4	1	1	2	3	4	5	6	7	7	6
Estimated Madera Canal Losses (1,000 acre-feet)											
Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0	0	0	0	0	0	0	2	3	4	3	0

**BENCHMARK MODEL LOGIC**

**Delivery Logic**

Annual water deliveries for the Friant Division are determined in March of each year and updated monthly through June. The allocation is estimated by summing the total water available from storage and inflow and subtracting requirements and losses. The remainder is the water available for delivery. The following equation is used to estimate water delivery at any point during the allocation season:

Water available for delivery:

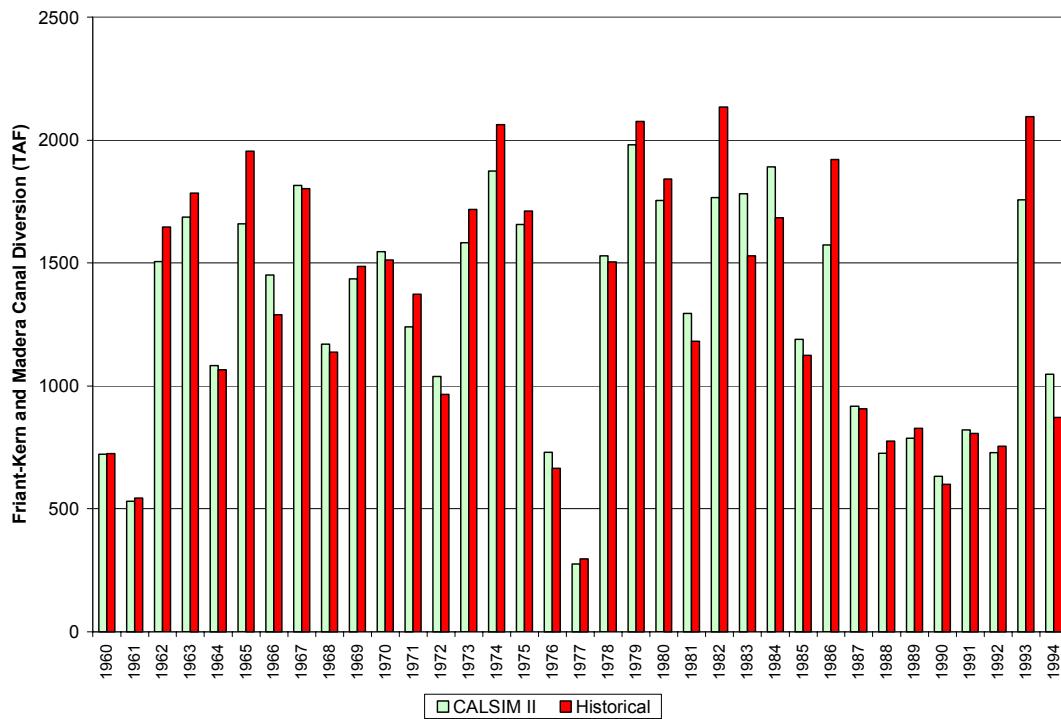
- = Sum current month through September Millerton inflow
- + Beginning of month Millerton Storage
- Millerton target (end of September) carryover storage
- Average current month through September evaporation
- Minimum Friant release to SJR for current month through September
- Losses for current month through September

Water is allocated to Class 1 and Class 2 deliveries based on the annual volume of available water. If the annual volume is less than the full Class 1 contract amount, Class 1 is set to the annual volume of available water. If the annual volume is greater than the Class 1 contract amount, Class 1 is set to full contract amount and the remainder is allocated to Class 2, up to the full Class 2 contract amount.

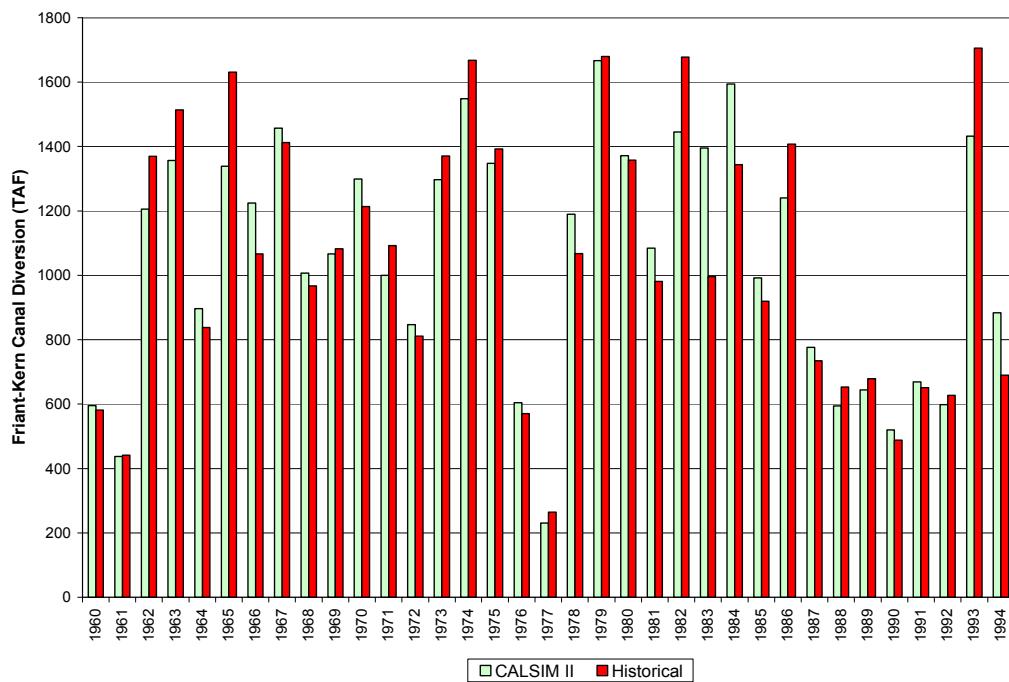
The monthly delivery patterns are based on the total annual volume of delivery. Lookup tables in the model contain the monthly delivery patterns (listed in Attachment A.5). Four lookup tables are used to determine monthly patterns for total delivery to the Friant-Kern and Madera canals and Class 1 delivery to the Friant-Kern and Madera canals. Monthly Class 2 delivery is the difference between total deliveries and Class 1 deliveries. The deliveries determined using this logic are based solely on water supply availability at Friant without consideration of wetness in the Friant service area and delivery of flood control releases. The adjustments for these factors are made subsequently in the model.

## SIMULATION/VALIDATION

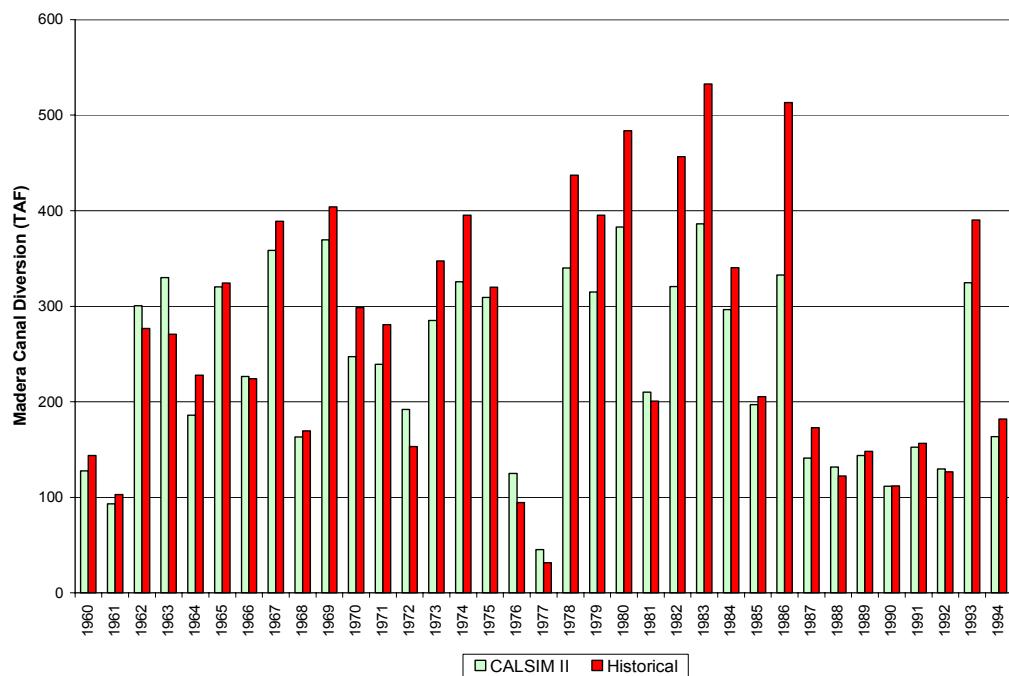
The water delivery function is integral to the development of the benchmark operation for the Friant Division. The total and separate annual canal diversions for the benchmark operation of the Friant Division are illustrated in Figures A.5 through A.7. Also shown are the historical canal diversions for the Friant Division. Most comparable are modeled and recorded diversions after 1961. Prior to 1961, Friant water user facilities were not completely built, and many of the facilities in the Tulare Lake Basin were incomplete.



**FIGURE A-5. ANNUAL TOTAL CANAL DELIVERY**

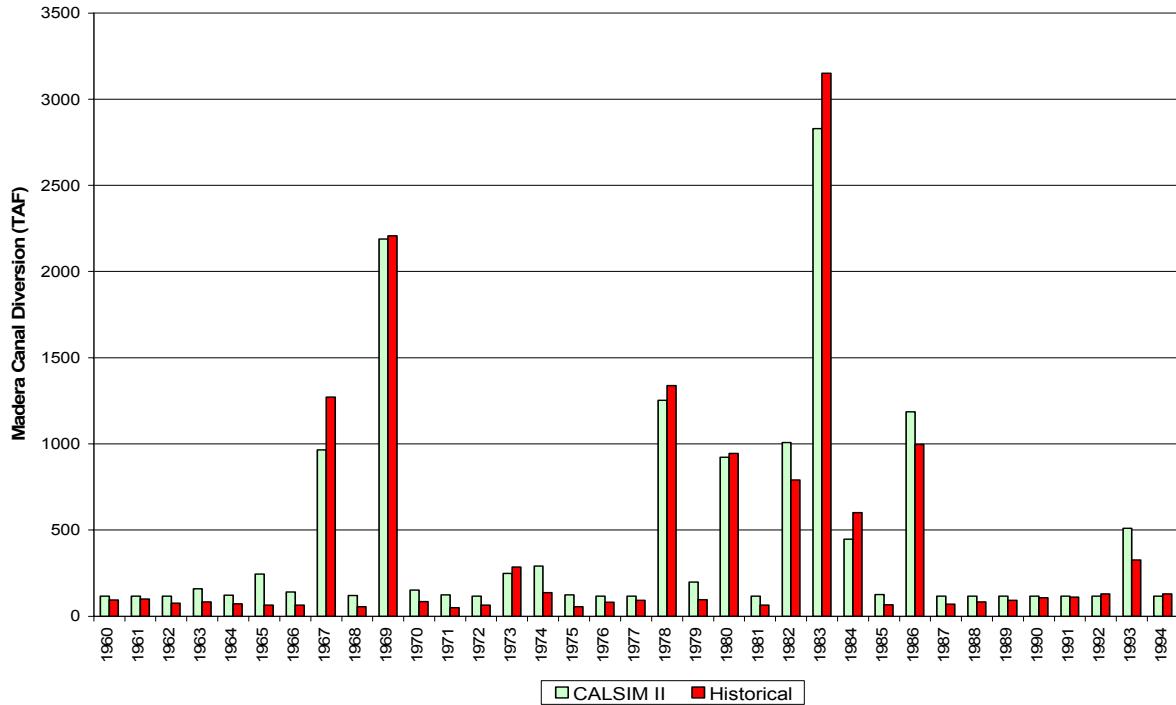


**FIGURE A-6. ANNUAL FRIANT-KERN CANAL DELIVERY**



**FIGURE A-7. ANNUAL MADERA CANAL DELIVERY**

A second component of comparison is the annual river release from Friant Dam. Figure A.8 depicts the modeled and historical annual release to the San Joaquin River.



**FIGURE A-8. ANNUAL RELEASE TO SAN JOAQUIN RIVER**

While at times there occur noticeable differences between historical and simulated annual delivery and river release volumes, the differences are reconciled in many instances and are largely due to the inability of the model to reflect discretionary and intermittent actions, such as flood management and canal maintenance.

The simulation of monthly operations for the entire 1922-1994 hydrologic period is shown in Attachment A.6. Illustrated are Millerton Lake storage, river releases, and canal releases. Also shown is a trace of historical operations since the beginning of Friant Division operations.

## **ATTACHMENTS**

### **Attachment A.1**

Upper San Joaquin Simulation Model Results used in CALSIM

Simulated Millerton Lake Inflow (USAN)

Simulated Mammoth Pool Storage (USAN)

### **Attachment A.2**

Conditional Space Release Matrices

### **Attachment A.3**

Historical River Releases

### **Attachment A.4**

Historical Delivery Data

### **Attachment A.5**

Water Delivery Pattern Matrices

### **Attachment A.6**

Monthly Simulation Results

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## **Attachment A.1**

Upper San Joaquin Simulation Model Results used in CALSIM

Simulated Millerton Lake Inflow (USAN)

Simulated Mammoth Pool Storage (USAN)

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**TABLE A.1-1**  
**MODELED MILLERTON INFLOW (1,000 ACRE-FEET)**

Modeled Millerton Inflow (1,000 acre-feet)													
USAN Base Plan - USBR October 2000													
WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1922	66	51	82	90	114	108	181	406	660	306	127	103	2294
1923	76	68	109	95	97	123	219	266	213	195	127	115	1703
1924	82	63	41	40	44	81	73	52	5	37	52	70	641
1925	31	37	39	40	90	80	188	208	201	155	106	89	1263
1926	74	55	47	42	75	99	232	242	129	58	77	98	1226
1927	50	74	74	66	158	141	230	297	377	207	112	98	1888
1928	80	114	67	59	72	154	163	206	135	81	111	100	1347
1929	31	29	34	34	38	62	79	156	119	112	85	97	878
1930	28	22	25	34	48	69	128	81	149	94	83	98	859
1931	34	30	27	32	37	40	77	59	18	39	46	69	507
1932	28	15	71	79	171	128	209	245	398	259	115	97	1818
1933	73	61	41	51	54	95	124	57	259	186	124	110	1237
1934	49	32	59	66	65	121	135	44	20	51	69	70	782
1935	39	40	50	81	93	84	251	322	385	158	101	98	1703
1936	77	68	44	64	204	186	265	351	253	159	109	98	1878
1937	66	60	61	59	236	231	269	442	401	173	87	87	2172
1938	76	65	214	122	225	328	421	595	863	433	219	107	3666
1939	91	64	55	75	83	153	218	105	66	70	83	99	1164
1940	60	30	27	141	133	180	233	334	278	111	81	91	1707
1941	64	59	113	136	199	213	248	414	556	347	159	100	2608
1942	84	70	116	148	137	153	267	267	489	300	131	95	2256
1943	77	91	70	153	178	255	280	344	251	170	118	102	2090
1944	67	63	46	55	74	111	114	200	205	166	126	106	1334
1945	63	83	80	66	242	146	216	295	356	254	138	110	2051
1946	110	119	149	108	76	133	236	304	208	128	96	102	1765
1947	81	107	110	72	82	128	134	199	98	74	98	104	1289
1948	45	36	33	35	35	33	129	176	235	134	87	99	1077
1949	63	41	40	40	46	71	170	218	203	83	101	105	1181
1950	63	44	42	64	105	78	208	205	190	106	89	102	1295
1951	70	191	313	217	135	119	170	141	178	146	125	106	1909
1952	57	42	90	163	114	151	287	571	591	334	195	110	2705
1953	73	50	67	122	83	108	146	103	169	211	132	108	1372
1954	51	38	39	53	79	109	206	253	164	100	82	80	1255
1955	61	50	56	63	68	83	99	144	247	123	121	106	1221
1956	48	35	319	284	224	226	251	327	505	306	182	112	2818
1957	92	67	47	61	92	103	115	157	291	168	120	105	1417
1958	69	50	68	64	125	170	285	541	561	313	176	117	2538
1959	77	51	41	71	117	168	171	103	98	71	79	123	1171
1960	49	26	26	33	66	73	140	105	92	72	78	77	837
1961	31	38	48	34	44	46	97	55	55	54	79	71	652
1962	37	29	38	37	183	87	264	270	335	213	115	103	1717
1963	79	63	38	63	243	142	197	229	365	269	149	118	1959
1964	83	109	69	56	54	94	94	117	134	91	119	100	1121
1965	31	50	148	248	141	104	192	237	318	264	216	122	2072
1966	77	140	101	88	77	144	224	204	116	74	100	106	1453
1967	37	46	232	101	121	181	233	391	720	596	246	141	3044
1968	83	51	61	77	109	137	126	117	87	74	85	94	1101
1969	38	55	67	258	245	237	410	836	848	466	228	104	3793
1970	86	61	73	186	119	176	142	166	222	139	129	106	1604
1971	52	58	96	92	88	92	147	144	199	158	138	115	1380
1972	65	53	81	63	68	150	92	126	141	81	107	131	1155
1973	44	49	64	94	131	110	190	424	393	147	96	93	1838
1974	84	130	118	165	91	218	262	354	388	170	123	99	2207
1975	80	70	60	63	97	150	136	279	473	185	107	110	1809
1976	105	83	53	44	59	117	63	56	20	58	80	102	840
1977	46	23	21	25	26	21	45	10	29	38	36	62	383
1978	25	15	86	166	198	241	263	492	725	464	242	216	3133
1979	90	59	59	131	134	209	250	337	283	126	104	102	1883
1980	80	77	57	261	274	260	290	385	499	425	211	114	2932
1981	87	60	55	69	87	130	151	191	137	82	114	109	1272
1982	44	88	82	132	177	219	454	547	529	347	238	187	3048
1983	225	185	221	241	264	376	313	531	1119	687	332	195	4688
1984	106	176	208	200	142	192	215	244	209	164	150	126	2133
1985	81	90	68	63	74	106	197	187	109	79	97	115	1266
1986	50	56	86	106	325	393	349	463	518	245	133	107	2831
1987	90	59	41	52	69	120	130	125	71	64	76	88	984
1988	42	40	41	71	58	79	119	88	82	79	81	83	865
1989	31	28	36	37	49	111	194	120	86	71	79	89	931
1990	50	38	34	40	46	76	136	53	55	80	76	70	754
1991	32	20	24	24	24	99	103	121	199	126	95	110	978
1992	42	39	38	40	80	80	156	120	32	73	76	78	855
1993	35	33	47	195	131	185	247	472	518	323	153	104	24433
1994	82	56	48	57	72	129	118	130	106	67	87	98	1050
1995	67	60	65	216	131	324	330	465	762	752	306	157	3635
1996	78	44	73	108	237	258	281	402	358	184	123	104	2248
1997	74	137	224	606	244	260	277	404	258	137	104	107	2831
1998	73	71	62	122	227	203	267	272	704	673	251	148	3073
1999	91	68	77	105	144	135	164	215	262	129	113	105	1608
Average	66	63	79	103	121	147	198	255	296	192	125	106	1745

**TABLE A.1-2**  
**MODELED MAMMOTH POOL INFLOW (1,000 ACRE-FEET)**

Modeled Mammoth Pool Storage (Acre-feet)

USAN Base Plan - USBR October 2000

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	32296	29247	27737	23500	21433	22899	45153	123000	123000	90744	61712	36116
1923	32896	30658	28743	26572	24011	20207	24789	123000	121841	87420	60972	36342
1924	32583	29516	26528	23521	20834	10726	16641	67041	82982	59070	35242	12213
1925	17429	17082	16287	13897	13196	18956	27198	116023	120087	87006	60880	36045
1926	32305	29130	25928	22818	20558	16134	89576	123000	105020	78957	53581	29173
1927	27410	26240	22286	19592	24372	22896	60172	123000	121351	87462	60919	36071
1928	33332	30863	28033	25628	23302	32568	28850	92353	92076	66578	41613	17631
1929	20244	18420	16641	14709	13062	11843	21698	74287	94171	64233	39356	15478
1930	17805	16875	15193	13684	12678	12703	21334	74481	89719	63938	39261	15508
1931	18594	17039	15214	13744	12265	10876	17809	68101	84370	60270	36461	13240
1932	16168	16975	23280	14863	14270	23967	29596	123000	123000	86653	60119	35288
1933	32835	30340	27921	25756	23408	14702	22526	102367	118466	78213	52542	28123
1934	26806	24038	21683	19022	17179	13156	17699	65733	85319	61013	36951	13659
1935	18699	17314	15558	14535	12993	23708	96208	123000	121829	87061	60978	36102
1936	32865	30427	27997	25638	31604	24170	97578	123000	121359	86761	60052	35184
1937	32692	29880	28074	25157	47725	23735	63964	123000	123000	87135	60831	36019
1938	32821	30381	42553	26377	25387	121411	123000	123000	123000	122492	62071	36602
1939	33545	30630	28070	25852	23510	12805	25634	73962	88055	63625	38602	15161
1940	18799	16989	15270	15029	25356	34814	65167	123000	115645	85877	59917	35154
1941	32588	29744	33875	25326	24114	23533	32818	123000	103820	61150	36110	
1942	33078	30975	32144	27180	24074	23034	61646	123000	123000	96090	61018	36080
1943	32831	30802	28532	58084	24642	54317	109619	123000	116226	87566	60910	36090
1944	32585	29933	27221	24758	23183	16856	23110	110741	112689	83561	57611	32938
1945	30533	27901	24883	21394	23644	23106	74925	123000	123000	87585	60968	36112
1946	38999	31014	29677	25893	23795	22990	84184	123000	114006	87005	60889	36114
1947	32423	30221	27141	23642	21307	12534	22772	75024	89538	64187	39501	15721
1948	19089	17049	15304	13669	12270	16754	23048	118241	121665	85845	59965	35277
1949	32036	28737	25544	22250	19650	15804	49125	123000	110985	84611	58766	34144
1950	30616	27773	24403	21546	19582	17875	62063	123000	113919	86525	60775	35999
1951	32658	93498	89393	23412	20157	15846	23319	106344	115127	79372	53748	29265
1952	27703	25047	33373	20691	18049	29995	112893	123000	123000	119705	60298	35414
1953	32819	30370	28885	26152	23707	15088	41437	84539	121885	78346	52479	28101
1954	26707	24132	21448	18957	17273	17969	64646	123000	113542	86903	60738	35992
1955	31912	28812	25666	22612	19832	15264	21881	108446	109845	77931	52481	28081
1956	26578	24201	123000	12284	68230	28216	53012	123000	123000	120999	60506	35543
1957	33226	30503	28025	25596	24599	16740	23850	100307	123000	86064	60128	35421
1958	31818	28530	25265	22443	21493	33070	103849	123000	123000	99073	61277	36342
1959	32890	30439	27870	25472	24357	12192	22988	72799	88089	63247	38563	15302
1960	18551	16902	15256	13733	12476	12127	20370	75323	87237	62655	37782	14185
1961	18584	17198	15393	13835	12308	11386	18128	70098	85825	61418	37291	13979
1962	18616	17236	15445	13830	16649	23321	107286	123000	123000	87521	60999	36165
1963	32852	30327	27659	57522	41120	22095	24326	123000	123000	97263	61045	35913
1964	32975	30537	27662	25033	22403	11922	21613	75986	88472	62929	38421	14598
1965	18668	17338	67799	28439	14190	21873	54410	123000	123000	97984	61401	36246
1966	32768	31230	29859	25429	23009	16750	40271	98675	98290	72413	47026	23206
1967	23279	22344	19326	23299	15641	54476	62957	123000	123000	61813	36687	
1968	32860	31214	28119	25809	24548	12874	22266	74390	86642	62302	37383	13825
1969	18489	17064	15916	122591	119026	110770	123000	123000	123000	121953	61448	36431
1970	33156	30656	28256	26934	25121	15773	21717	118583	109749	78805	53006	28589
1971	27045	25192	22315	20076	17353	18124	22824	88535	121216	84778	58359	33455
1972	30458	27428	24871	21608	18943	11551	22279	77257	88528	63005	38421	14503
1973	18603	17373	15682	14226	16838	22318	53961	123000	123000	86875	60854	35960
1974	33004	31005	29376	26602	23702	26101	47357	123000	121435	88452	60629	36154
1975	33089	30558	28051	25575	24195	21083	23551	123000	119811	86884	60916	36352
1976	33407	30337	27522	24789	23211	11372	16718	69639	83623	60427	35587	12565
1977	18529	16915	15344	13641	12168	10479	14511	52722	83541	59230	35654	12649
1978	15267	16957	16705	14493	14207	70310	123000	123000	123000	123000	61503	36353
1979	33066	30768	28113	26541	24653	27964	36959	123000	114436	87039	60927	36240
1980	32731	30019	29499	90612	107566	92995	123000	123000	123000	122989	60486	35659
1981	32948	30488	28023	25884	23635	12666	37228	81732	93291	67817	42785	18597
1982	20670	19124	18167	15956	38744	32797	123000	123000	123000	122921	62066	72937
1983	43761	38339	52416	58078	73382	123000	123000	123000	123000	99782	37830	
1984	33625	33197	63629	26604	24437	19305	22950	123000	114752	87080	60327	35349
1985	32764	29913	26288	22939	20929	12991	31719	77055	93677	68450	43401	19380
1986	20996	19922	18554	17545	123000	123000	123000	123000	123000	87693	61229	36664
1987	32994	30400	27886	25370	23155	11565	24030	71730	87483	62541	38140	14738
1988	18985	17032	15526	14151	14047	12253	20238	73489	87034	62136	37643	13913
1989	17568	17296	15469	13838	12708	13002	24197	72610	88898	63698	39071	15891
1990	18683	17185	15388	13716	12815	12031	19687	70604	86890	62013	37818	14354
1991	18284	16974	15256	13616	12579	13974	23475	88491	101136	72007	46550	22699
1992	23111	20845	18619	16216	15363	12212	28623	73203	86575	61977	37543	14073
1993	19118	17089	15721	14851	14067	48815	101580	123000	123000	100645	61291	35974
1994	32766	30885	27910	25393	23819	11969	19904	76819	88198	62993	38664	15362
1995	18899	17737	15889	16739	14262	123000	123000	123000	123000	123000	85680	36351
1996	33266	30472	28595	27864	36269	25214	79222	123000	115325	86708	60206	35216
1997	32922	30540	41505	123000	91093	78172	115575	123000	116008	87170	60926	36280
1998	32674	30112	27101	24835	23219	51244	80718	123000	123000	122845	62118	36631
1999	33129	31715	28480	26669	24078	18330	25140	123000	118036	86911	61252	36235

## Attachment A.2

### Conditional Space Release Matrices

**TABLE A.2-1**  
**FEBRUARY FORECASTED SPILL TABLE**

Forecast Spill (TAF)	Percent of spill volume release each month												Jan TOTAL
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
100	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
200	0.0	0.0	33.3	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
300	0.0	25.0	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
400	20.0	20.0	20.0	20.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
500	16.7	16.7	16.7	16.7	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
600	14.3	14.3	14.3	28.6	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
700	12.5	12.5	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
800	11.1	22.2	22.2	22.2	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
900	20.0	20.0	20.0	20.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1000	18.2	18.2	18.2	18.2	27.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1100	16.7	16.7	16.7	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1200	15.4	15.4	23.1	23.1	23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1300	14.3	21.4	21.4	21.4	21.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1400	20.0	20.0	20.0	20.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1500	20.0	20.0	20.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

**TABLE A.2-2**  
**MARCH FORECASTED SPILL TABLE**

Forecast Spill (TAF)	Percent of spill volume release each month												Jan TOTAL
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
100	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
200	0.0	33.3	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
300	25.0	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
400	25.0	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
400	20.0	20.0	20.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
500	16.7	16.7	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
600	14.3	28.6	28.6	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
700	25.0	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
800	22.2	22.2	22.2	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
900	20.0	20.0	30.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1000	18.2	27.3	27.3	27.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1100	25.0	25.0	25.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1200	23.1	23.1	23.1	30.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1300	21.4	21.4	28.6	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1400	21.4	21.4	28.6	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

**TABLE A.2-3**  
**APRIL FORECASTED SPILL TABLE**

Forecast Spill (TAF)	Percent of spill volume release each month										
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	TOTAL
0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
100	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
200	33.3	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
300	25.0	25.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
400	20.0	40.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
500	33.3	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
600	28.6	28.6	42.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
700	25.0	37.5	37.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
800	33.3	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
900	30.0	30.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1000	27.3	36.4	36.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1100	27.3	36.4	36.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

**TABLE A.2-4**  
**MAY FORECASTED SPILL TABLE**

Forecast Spill (TAF)	Percent of spill volume release each month										
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	TOTAL	
0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
100	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
200	33.3	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
300	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
400	40.0	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
500	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
600	42.9	57.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
700	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
800	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

## Attachment A.3

### Historical River Releases

**TABLE A.3-1**  
**HISTORICAL RIVER RELEASE (1,000 ACRE-FEET)**

**Historical River Release (1,000 acre-feet)**  
**USBR Report of Operations**

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1981	4.8	4.3	2.2	3.1	2.6	2.5	4.9	6.2	7.7	11.0	8.5	7.5	65.2
1982	6.2	5.5	3.4	2.7	2.0	8.6	409.0	231.3	88.6	22.4	6.1	4.6	790.5
1983	4.2	92.2	228.1	222.5	281.4	437.4	465.9	379.9	526.9	311.1	81.5	118.9	3,150.0
1984	73.1	75.8	133.0	241.0	22.0	5.0	12.7	6.2	7.7	9.2	8.4	6.9	601.0
1985	5.6	3.1	1.8	1.9	1.7	2.8	6.6	8.0	9.1	9.9	8.7	7.8	67.0
1986	6.6	4.1	3.3	3.5	201.0	416.1	288.2	17.2	31.8	9.6	8.4	7.4	997.1
1987	4.2	4.5	2.4	2.2	2.5	2.1	7.9	8.0	8.6	10.2	9.2	7.8	69.7
1988	7.1	4.0	3.7	3.1	3.6	6.7	6.0	8.0	9.4	11.6	11.3	9.1	83.6
1989	8.3	6.1	3.5	2.1	4.1	5.7	7.7	9.1	10.3	12.6	12.6	9.5	91.7
1990	7.9	6.5	6.3	3.3	4.5	7.1	9.9	11.6	11.9	14.0	13.7	10.8	107.5
1991	9.5	7.9	6.8	6.7	8.0	4.8	7.4	10.6	11.9	13.6	12.9	10.6	110.7
1992	10.0	7.6	6.7	5.3	4.5	6.7	9.2	13.1	16.5	16.8	17.8	15.4	129.6
1993	12.9	7.8	7.3	3.0	2.0	26.5	72.2	56.7	63.5	42.0	18.1	15.3	327.1
1994	10.3	7.5	6.4	6.8	6.3	9.5	10.0	10.5	13.0	16.6	16.4	14.8	128.2
1995	11.1	8.4	6.8	2.9	20.8	228.0	340.8	451.7	156.6	324.2	28.8	11.8	1,591.9
1996	10.3	8.4	5.4	4.7	35.0	97.4	68.2	99.7	20.3	14.6	13.9	12.3	390.1
1997	10.7	6.7	63.5	544.5	353.5	80.2	13.9	17.4	17.3	18.6	20.6	18.3	1,165.3
1998	15.7	12.2	10.8	6.2	173.7	146.1	272.7	252.0	392.8	270.3	25.1	25.5	1,603.0
1999	23.9	24.4	34.9	17.1	28.1	5.1	5.9	9.2	24.7	35.2	19.6	13.8	241.8
2000	9.6	6.0	5.2	5.3	2.9	53.9	8.0	7.8	27.7	14.1	14.9	14.5	169.8

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# Attachment A.4

## Historical Delivery Data

**TABLE A.4-1**  
**FRIANT-KERN CANAL**

Fri	Data used in development of delivery distribution curves												Ti		
	Used in development of Class 1 only supply curves				Used in development of full Class 1 and full Class 2 curves										
	Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2
1982-83	0	0	4	20	87	176	85	59	29	9	16	12	16	497	100/100
1983-84	0	0	2	6	69	147	119	66	55	3	0	0	152	619	100/100
1984-85	5	27	60	123	171	76	45	43	27	1	0	0	83	661	100/50
1985-86	78	77	99	135	132	69	17	18	4	1	3	18	18	651	100/14
1986-87	0	4	11	28	124	132	128	71	33	24	16	69	640	100/100	
1987-88	26	62	49	84	110	85	53	39	3	2	6	101	620	91/0	
1988-89	44	22	48	101	133	71	38	27	9	0	0	13	506	78/0	
1989-90	33	68	61	122	155	89	42	32	19	4	2	11	638	98/0	
1990-91	50	28	34	52	88	92	46	31	15	0	0	8	444	68/0	
1991-92	1	14	60	122	175	107	58	57	17	1	0	7	619	100/0	
1992-93	21	40	66	144	100	97	42	28	9	0	0	53	600	83/0	
1993-94	0	1	13	58	173	165	79	48	21	6	12	16	592	100/90	
1994-95	25	34	35	129	147	97	47	19	5	1	4	38	581	80/0	
1995-96	0	1	2	9	51	75	85	61	36	15	2	34	371	100/100	
1996-97	0	3	16	106	227	133	67	55	7	1	0	0	615	100/58	
1997-98	2	6	34	108	178	125	67	46	22	10	6	8	612	100/60	
 Class 1 (Monthly Distribution % of Annual)															
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2	
1982-83	0	0	1	4	35	17	12	6	2	2	3	3	100	100/100	
1983-84	0	0	0	1	24	19	11	9	0	0	0	25	100	100/100	
1984-85	1	4	9	19	26	11	7	4	0	0	0	13	100	100/50	
1985-86	12	12	15	21	20	11	3	3	1	0	0	3	100	100/14	
1986-87	0	1	2	4	19	21	20	11	5	4	3	11	100	100/100	
1987-88	4	10	8	14	18	14	9	6	0	0	1	16	100	91/0	
1988-89	9	4	9	20	26	14	8	5	2	0	0	3	100	78/0	
1989-90	5	11	10	19	24	14	7	5	3	1	0	2	100	98/0	
1990-91	11	6	8	12	20	21	10	7	3	0	0	2	100	68/0	
1991-92	0	2	10	20	28	17	9	9	3	0	0	1	100	100/0	
1992-93	4	7	11	24	17	16	7	5	2	0	0	9	100	83/0	
1993-94	0	0	2	10	29	28	13	8	4	1	2	3	100	100/90	
1994-95	4	6	6	22	25	17	8	3	1	0	1	7	100	80/0	
1995-96	0	0	1	2	14	20	23	16	10	4	1	9	100	100/100	
1996-97	0	0	3	17	37	22	11	9	1	0	0	0	100	100/55	
1997-98	0	11	6	18	29	20	11	8	4	2	1	11	100	100/60	
Avg	5	6	9	20	26	15	8	6	2	0	0	3	100		
Avg	0	0	2	7	24	24	17	10	4	2	2	7	100		
 Class 2 (Absolute Delivery TAF)															
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2	
1982-83	111	71	118	230	174	75	14	1	0	0	0	0	794	100/100	
1983-84	3	50	108	156	154	21	0	0	0	0	0	0	492	100/100	
1984-85	98	48	57	83	52	82	52	31	1	2	0	13	519	100/50	
1985-86	0	0	0	6	3	15	35	31	2	0	3	36	131	100/14	
1986-87	42	108	181	215	118	69	33	3	0	0	0	0	769	100/100	
1987-88	0	0	0	0	0	0	0	0	0	0	0	0	0	91/0	
1988-89	0	0	0	0	0	0	0	0	1	1	0	0	2	78/0	
1989-90	0	0	0	0	0	0	0	0	0	0	0	0	0	98/0	
1990-91	0	0	0	0	0	0	0	0	0	1	2	0	0	68/0	
1991-92	0	0	0	0	0	0	0	0	0	0	0	0	0	100/0	
1992-93	0	0	0	0	0	0	0	0	0	2	2	0	2	63/0	
1993-94	171	141	218	198	100	71	17	18	0	0	0	0	934	100/90	
1994-95	1	1	1	2	2	1	1	1	0	0	0	24	34	80/0	
1995-96	50	67	47	90	150	168	58	36	26	13	20	12	737	100/100	
1996-97	54	123	153	130	26	51	21	0	0	0	0	0	558	100/58	
1997-98	95	146	103	112	52	29	20	26	2	2	0	0	587	100/60	
 Other (Absolute Delivery TAF)															
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2	
1982-83	0	24	89	0	0	0	0	0	0	0	0	0	113	100/100	
1983-84	0	0	0	0	3	0	0	0	0	0	0	0	3	100/100	
1984-85	0	0	0	0	0	0	0	0	0	0	0	0	0	100/50	
1985-86	0	0	0	0	0	0	0	0	0	0	0	0	0	100/14	
1986-87	9	4	2	0	0	0	0	0	0	0	0	0	17	100/100	
1987-88	0	0	0	0	0	0	0	0	0	0	0	0	0	91/0	
1988-89	0	0	0	0	0	0	0	0	0	0	0	0	0	78/0	
1989-90	0	0	0	0	0	0	0	0	0	0	0	0	0	98/0	
1990-91	0	0	0	0	0	0	0	0	0	0	0	0	0	68/0	
1991-92	0	0	0	0	0	0	0	0	0	0	0	0	0	100/0	
1992-93	0	0	0	0	0	0	0	0	0	0	0	0	0	63/0	
1993-94	0	80	25	8	9	0	0	0	0	0	0	0	0	122 100/90	
1994-95	0	0	0	0	0	0	0	0	0	0	0	22	22	80/0	
1995-96	20	8	77	141	32	1	0	0	0	0	0	0	0	279 100/100	
1996-97	19	44	49	20	0	0	0	0	0	0	13	18	163	100/58	
1997-98	5	0	0	0	0	0	0	0	0	0	0	13	18	100/60	

**TABLE A.4-2**  
**FRIANT-KERN CANAL**

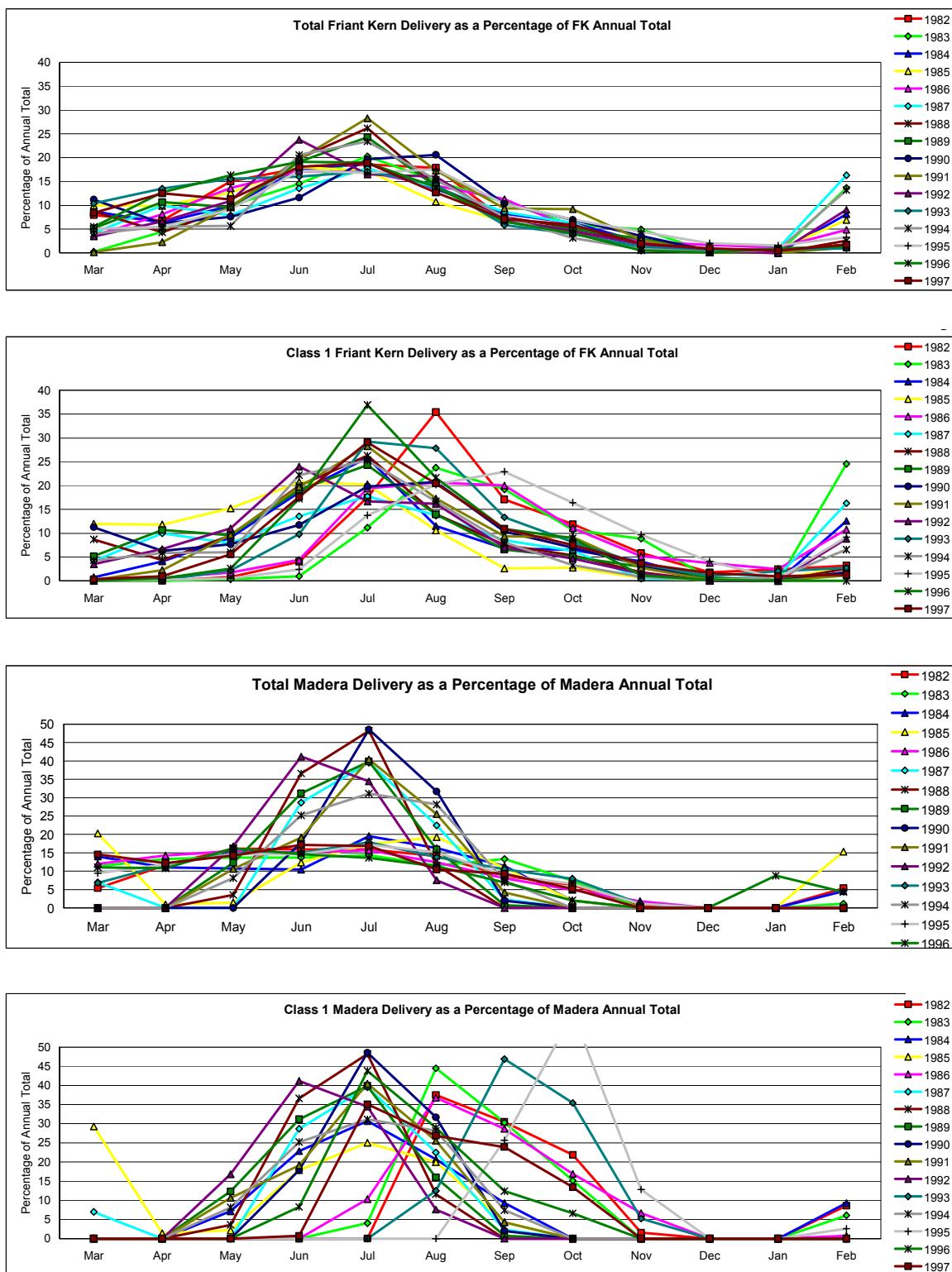
Fr..... Total (Absolute Delivery TAF)													Data used in development of delivery distribution curves			
													Used in development of Class 1 only supply curves			
													Used in development of full Class 1 and full Class 2 curves			
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	C1/C2		
1982-83	111	95	211	250	261	251	99	60	29	9	12	16	1404	100/100		
1983-84	3	50	110	162	226	168	119	66	55	3	0	152	1114	100/100		
1984-85	103	75	117	206	223	158	97	74	28	3	0	96	1180	100/50		
1985-86	78	77	99	141	135	84	52	49	6	1	6	54	782	100/14		
1986-87	51	116	194	245	242	201	161	74	33	24	16	69	1426	100/100		
1987-88	26	62	49	84	110	85	53	39	3	2	6	101	620	91/0		
1988-89	44	22	48	101	133	71	38	27	10	1	0	13	508	78/0		
1989-90	33	68	61	122	155	89	42	32	19	4	2	11	638	98/0		
1990-91	50	28	34	52	88	92	46	31	16	2	0	8	447	68/0		
1991-92	1	14	60	122	175	107	58	57	17	1	0	7	619	100/0		
1992-93	21	40	66	144	100	97	42	28	11	2	0	55	606	83/0		
1993-94	171	222	256	264	282	236	96	66	21	6	12	16	1648	100/90		
1994-95	26	35	36	131	149	98	48	20	5	1	4	84	637	80/0		
1995-96	70	76	126	240	233	244	143	97	62	28	22	46	1387	100/100		
1996-97	73	170	218	256	253	184	88	55	7	1	13	18	1336	100/58		
1997-98	102	152	137	220	230	154	87	72	24	12	6	21	1217	100/60		
Total (Percentage of Annual Total)																
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	C1/C2		
1982-83	8	7	15	18	19	18	7	4	2	1	1	1	100	100/100		
1983-84	0	4	10	15	20	15	11	6	5	0	0	14	100	100/100		
1984-85	9	6	10	17	19	13	8	6	2	0	0	8	100	100/50		
1985-86	10	10	13	18	17	11	7	6	1	0	1	7	100	100/14		
1986-87	4	8	14	17	17	14	11	5	2	2	1	5	100	100/100		
1987-88	4	10	8	14	18	14	9	6	0	0	1	16	100	91/0		
1988-89	9	4	9	20	26	14	7	5	2	0	0	3	100	78/0		
1989-90	5	11	10	19	24	14	7	5	3	1	0	2	100	98/0		
1990-91	11	6	8	12	20	21	10	7	4	0	0	2	100	68/0		
1991-92	0	2	10	20	28	17	9	9	3	0	0	1	100	100/0		
1992-93	3	7	11	24	17	16	7	5	2	0	0	9	100	83/0		
1993-94	10	13	16	16	17	14	6	4	1	0	1	1	100	100/90		
1994-95	4	5	6	21	23	15	8	3	1	0	1	13	100	80/0		
1995-96	5	5	9	17	17	18	10	7	4	2	2	3	100	100/100		
1996-97	5	13	16	19	19	14	7	4	1	0	1	1	100	100/58		
1997-98	8	12	11	18	19	13	7	6	2	1	0	2	100	100/60		
Avg	5	6	9	20	26	15	8	6	2	0	0	5	100			
Avg	7	11	15	17	17	14	9	5	2	1	1	3	100			

**TABLE A.4-3  
MADERA CANAL**

Madera Canal														Cl1/Cl2		
Data used in development of delivery distribution curves																
Used in development of Class 1 only supply curves																
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total			
1982-83	0	0	0	0	0	48	39	28	2	0	0	11	128	100/100		
1983-84	0	0	0	0	4	44	30	15	0	0	0	6	99	100/100		
1984-85	0	0	10	32	43	29	13	0	0	0	0	13	140	100/50		
1985-86	41	2	3	25	35	28	6	0	0	0	0	0	140	100/14		
1986-87	0	0	0	0	14	50	39	23	9	0	0	1	136	100/100		
1987-88	9	0	0	37	51	29	3	0	0	0	0	0	129	91/0		
1988-89	0	0	4	41	54	13	0	0	0	0	0	0	112	78/0		
1989-90	0	0	17	43	55	22	1	0	0	0	0	0	138	98/0		
1990-91	0	0	0	18	49	32	2	0	0	0	0	0	101	68/0		
1991-92	0	0	15	27	57	36	6	0	0	0	0	0	141	100/0		
1992-93	0	0	20	49	41	9	0	0	0	0	0	0	119	83/0		
1993-94	0	0	0	0	0	12	45	34	5	0	0	0	96	100/90		
1994-95	0	0	11	34	42	38	10	0	0	0	0	0	135	80/0		
1995-96	0	0	0	0	0	0	10	23	5	0	0	1	39	100/100		
1996-97	0	0	0	10	53	35	15	8	0	0	0	0	121	100/58		
1997-98	0	0	0	1	47	36	32	18	0	0	0	0	134	100/60		
Class 1 (Montly Distribution % of Annual)														68		
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2		
1982-83	0	0	0	0	0	38	30	22	2	0	0	9	100	100/100		
1983-84	0	0	0	0	4	44	30	15	0	0	0	6	100	100/100		
1984-85	0	0	7	23	31	21	9	0	0	0	0	9	100	100/50		
1985-86	29	1	2	18	25	20	4	0	0	0	0	0	100	100/14		
1986-87	0	0	0	0	10	37	29	17	7	0	0	1	100	100/100		
1987-88	7	0	0	29	40	22	2	0	0	0	0	0	100	91/0		
1988-89	0	0	4	37	48	12	0	0	0	0	0	0	100	78/0		
1989-90	0	0	12	31	40	16	1	0	0	0	0	0	100	98/0		
1990-91	0	0	0	18	49	32	2	0	0	0	0	0	100	68/0		
1991-92	0	0	11	19	40	26	4	0	0	0	0	0	100	100/0		
1992-93	0	0	17	41	34	8	0	0	0	0	0	0	100	83/0		
1993-94	0	0	0	0	0	13	47	35	5	0	0	0	100	100/90		
1994-95	0	0	8	25	31	28	7	0	0	0	0	0	100	80/0		
1995-96	0	0	0	0	0	0	26	59	13	0	0	3	100	100/100		
1996-97	0	0	0	8	44	29	12	7	0	0	0	0	100	100/58		
1997-98	0	0	0	1	35	27	24	13	0	0	0	0	100	100/60		
Avg	0	0	9	28	40	20	3	0	0	0	0	0	100			
Avg	0	0	0	0	5	25	38	26	6	0	0	0	100			
Class 2 (Absolute Delivery TAF)														68		
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2		
1982-83	24	23	70	71	71	15	0	0	0	0	0	0	274	100/100		
1983-84	16	30	52	66	67	7	0	0	0	0	0	0	238	100/100		
1984-85	43	34	23	0	17	21	22	6	0	0	0	1	167	100/50		
1985-86	0	0	0	0	0	11	16	4	0	0	0	12	43	100/14		
1986-87	28	49	74	72	62	10	0	1	0	0	0	0	296	100/100		
1987-88	0	0	0	0	0	0	0	0	0	0	0	0	0	91/0		
1988-89	0	0	0	0	0	0	0	0	0	0	0	0	0	78/0		
1989-90	0	0	0	0	0	0	0	0	0	0	0	0	0	98/0		
1990-91	0	0	0	0	0	0	0	0	0	0	0	0	0	68/0		
1991-92	0	0	0	0	0	0	0	0	0	0	0	0	0	100/0		
1992-93	0	0	0	0	0	0	0	0	0	0	0	0	0	83/0		
1993-94	29	49	63	62	74	47	0	0	0	0	0	0	324	100/90		
1994-95	0	0	0	0	0	0	0	0	0	0	0	0	0	80/0		
1995-96	12	17	21	31	40	61	28	5	0	0	0	0	215	100/100		
1996-97	13	42	54	46	0	9	12	0	0	0	0	0	176	100/58		
1997-98	38	42	49	58	11	0	0	0	0	0	0	0	198	100/60		
Other (Absolute Delivery TAF)														68		
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2		
1982-83	0	29	2	0	0	0	0	0	0	0	0	13	44	100/100		
1983-84	42	38	18	4	2	8	38	23	0	0	0	0	173	100/100		
1984-85	0	0	0	0	0	0	0	0	0	0	0	0	0	100/50		
1985-86	0	0	0	0	0	0	0	0	0	0	0	19	19	100/14		
1986-87	30	20	1	1	0	0	0	0	0	0	0	0	52	100/100		
1987-88	0	0	0	0	0	0	0	0	0	0	0	0	0	91/0		
1988-89	0	0	0	0	0	0	0	0	0	0	0	0	0	78/0		
1989-90	0	0	0	0	0	0	0	0	0	0	0	0	0	98/0		
1990-91	0	0	0	0	0	0	0	0	0	0	0	0	0	68/0		
1991-92	0	0	0	0	0	0	0	0	0	0	0	0	0	100/0		
1992-93	0	0	0	0	0	0	0	0	0	0	0	0	0	83/0		
1993-94	0	1	1	2	2	0	0	0	0	0	0	0	6	100/90		
1994-95	0	0	0	0	0	0	0	0	0	0	0	0	0	80/0		
1995-96	28	33	41	31	33	3	0	0	0	0	0	0	169	100/100		
1996-97	30	0	9	1	0	0	0	0	0	0	0	34	17	91	100/58	
1997-98	12	0	0	0	0	0	0	0	0	0	0	0	12	100/60		

**TABLE A.4-4**  
**MADERA CANAL**

Madera Canal													T	
Data used in development of delivery distribution curves														
Used in development of Class 1 only supply curves														
Used in development of full Class 1 and full Class 2 curves														
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2
1982-83	24	52	72	71	71	63	39	28	2	0	0	24	446	100/100
1983-84	58	68	70	70	73	59	68	38	0	0	0	6	510	100/100
1984-85	43	34	33	32	60	50	35	6	0	0	0	14	307	100/50
1985-86	41	2	3	25	35	39	22	4	0	0	0	31	202	100/14
1986-87	58	69	75	73	76	60	39	24	9	0	0	1	484	100/100
1987-88	9	0	0	37	51	29	3	0	0	0	0	0	129	91/0
1988-89	0	0	4	41	54	13	0	0	0	0	0	0	112	78/0
1989-90	0	0	17	43	55	22	1	0	0	0	0	0	138	98/0
1990-91	0	0	0	18	49	32	2	0	0	0	0	0	101	68/0
1991-92	0	0	15	27	57	36	6	0	0	0	0	0	141	100/0
1992-93	0	0	20	49	41	9	0	0	0	0	0	0	119	83/0
1993-94	29	50	64	64	76	59	45	34	5	0	0	0	426	100/90
1994-95	0	0	11	34	42	38	10	0	0	0	0	0	135	80/0
1995-96	40	50	62	62	73	64	38	28	5	0	0	1	423	100/100
1996-97	43	42	63	57	53	44	27	8	0	0	34	17	388	100/58
1997-98	50	42	49	59	58	36	32	18	0	0	0	0	344	100/60
Total (Percentage of Annual Total)														
Mar-Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Yr-Total	Cl1/Cl2
1982-83	5	12	16	16	16	14	9	6	0	0	0	5	100	100/100
1983-84	11	13	14	14	14	12	13	7	0	0	0	1	100	100/100
1984-85	14	11	11	10	20	16	11	2	0	0	0	5	100	100/50
1985-86	20	1	1	12	17	19	11	2	0	0	0	15	100	100/14
1986-87	12	14	15	15	16	12	8	5	2	0	0	0	100	100/100
1987-88	7	0	0	29	40	22	2	0	0	0	0	0	100	91/0
1988-89	0	0	4	37	48	12	0	0	0	0	0	0	100	78/0
1989-90	0	0	12	31	40	16	1	0	0	0	0	0	100	98/0
1990-91	0	0	0	18	49	32	2	0	0	0	0	0	100	68/0
1991-92	0	0	11	19	40	26	4	0	0	0	0	0	100	100/0
1992-93	0	0	17	41	34	8	0	0	0	0	0	0	100	83/0
1993-94	7	12	15	15	18	14	11	8	1	0	0	0	100	100/90
1994-95	0	0	8	25	31	28	7	0	0	0	0	0	100	80/0
1995-96	9	12	15	15	17	15	9	7	1	0	0	0	100	100/100
1996-97	11	11	16	15	14	11	7	2	0	0	9	4	100	100/58
1997-98	15	12	14	17	17	10	9	5	0	0	0	0	100	100/60
Avg	0	0	9	28	40	20	3	0	0	0	0	0	100	
Avg	9	13	15	15	17	13	9	6	2	0	0	0	100	



**FIGURE A.4-1. MONTHLY WATER DELIVERY PERCENTAGES**

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## Attachment A.5

### Water Delivery Pattern Matrices

**TABLE A.5-1  
TOTAL FRIANT-KERN CANAL DELIVERY PATTERN**

Total Deliver,	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
0	5.0	6.0	9.0	20.0	26.0	15.0	8.0	6.0	2.0	0.0	0.0	3.0	100.0
800	6.0	10.0	13.0	16.0	19.0	16.0	9.0	4.0	1.0	1.0	1.0	4.0	100.0
900	6.0	10.0	13.0	16.0	19.0	16.0	9.0	4.0	1.0	1.0	1.0	4.0	100.0
1000	6.0	10.0	13.0	16.0	19.0	16.0	9.0	4.0	1.0	1.0	1.0	4.0	100.0
1100	6.0	10.0	13.0	16.0	19.0	16.0	9.0	4.0	1.0	1.0	1.0	4.0	100.0
1200	6.0	10.0	13.0	16.0	19.0	16.0	9.0	4.0	1.0	1.0	1.0	4.0	100.0
1300	6.0	10.0	13.0	16.0	19.0	16.0	9.0	4.0	1.0	1.0	1.0	4.0	100.0
1400	6.0	10.0	13.0	16.0	19.0	16.0	9.0	4.0	1.0	1.0	1.0	4.0	100.0
1500	5.0	5.0	8.0	15.0	18.1	15.6	9.0	6.0	2.0	2.0	2.0	8.0	95.7
1600	5.0	5.0	8.0	14.0	17.3	15.3	9.0	6.0	2.0	2.0	2.0	8.0	93.6
1700	5.0	5.0	8.0	13.2	16.4	14.9	9.0	6.0	2.0	2.0	2.0	8.0	91.5
1800	5.0	5.0	8.0	12.3	15.5	14.5	9.0	6.0	2.0	2.0	2.0	8.0	89.3
1900	5.0	5.0	8.0	11.5	14.6	14.1	9.0	6.0	2.0	2.0	2.0	8.0	87.2
2000	5.0	5.0	8.0	10.7	13.8	13.8	9.0	6.0	2.0	2.0	2.0	8.0	85.3
2100	5.0	5.0	8.0	9.8	12.9	13.4	9.0	6.0	2.0	2.0	2.0	8.0	83.1
2200	5.0	5.0	8.0	9.0	12.0	13.0	9.0	6.0	2.0	2.0	2.0	8.0	81.0

**TABLE A.5-2  
TOTAL MADERA CANAL DELIVERY PATTERN**

Total Delivery	Percent of annual delivery											
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
0	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
800	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
900	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
1000	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
1100	9.0	10.0	15.0	17.0	21.0	16.0	8.0	1.0	1.0	0.0	0.0	2.0
1200	9.0	10.0	15.0	17.0	21.0	16.0	8.0	1.0	1.0	0.0	0.0	2.0
1300	9.0	10.0	15.0	17.0	21.0	16.0	8.0	1.0	1.0	0.0	0.0	2.0
1400	9.0	10.0	15.0	17.0	21.0	16.0	8.0	1.0	1.0	0.0	0.0	2.0
1500	9.0	10.0	15.0	17.0	21.0	16.0	8.0	1.0	1.0	0.0	0.0	2.0
1600	9.0	12.0	14.0	15.0	15.0	14.0	10.0	6.0	1.0	0.0	0.0	4.0
1700	9.0	12.0	14.0	15.0	15.0	14.0	10.0	6.0	1.0	0.0	0.0	4.0
1800	9.0	12.0	14.0	15.0	15.0	14.0	10.0	6.0	1.0	0.0	0.0	4.0
1900	9.0	12.0	14.0	15.0	15.0	14.0	10.0	6.0	1.0	0.0	0.0	4.0
2000	9.0	12.0	14.0	15.0	15.0	14.0	10.0	6.0	1.0	0.0	0.0	4.0
2100	9.0	12.0	14.0	15.0	15.0	14.0	10.0	6.0	1.0	0.0	0.0	4.0
2200	9.0	12.0	14.0	15.0	15.0	14.0	10.0	6.0	1.0	0.0	0.0	4.0

**TABLE A.5-3**  
**FRIANT-KERN CANAL CLASS 1 DELIVERY PATTERN**

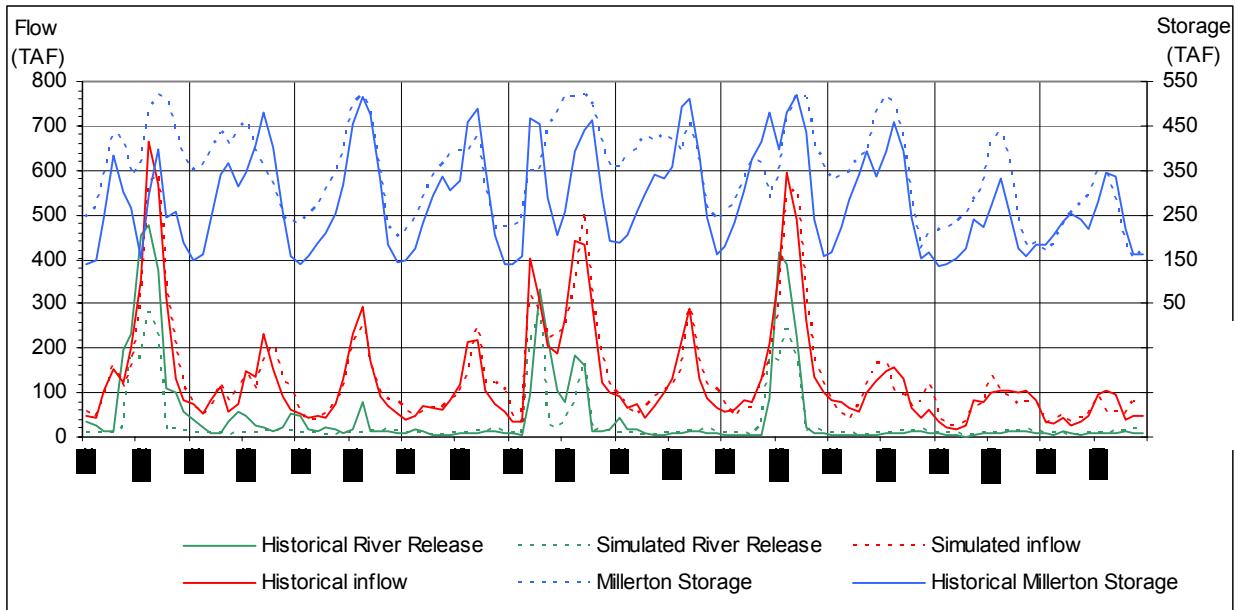
Total Delivery	Percent of annual delivery											
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
0	5.0	6.0	9.0	20.0	26.0	15.0	8.0	6.0	2.0	0.0	0.0	3.0
800	6.0	10.0	13.0	16.0	19.0	16.0	9.0	4.0	1.0	1.0	1.0	4.0
900	5.6	9.3	12.4	15.8	20.0	16.6	9.4	4.0	1.0	1.0	1.0	4.0
1000	5.1	8.6	11.7	15.6	20.9	17.1	9.9	4.0	1.0	1.0	1.0	4.0
1100	4.7	7.9	11.1	15.5	21.9	17.7	10.3	4.0	1.0	1.0	1.0	4.0
1200	4.3	7.1	10.4	15.3	22.6	18.3	10.7	4.0	1.0	1.0	1.0	4.3
1300	3.9	6.4	9.8	15.1	21.0	18.9	11.1	5.8	1.7	1.0	1.0	4.4
1400	3.4	5.7	9.1	14.9	21.4	19.4	11.6	6.1	1.9	1.0	1.0	4.4
1500	3.0	5.0	8.5	14.8	21.7	20.0	12.0	6.5	2.0	1.0	1.0	4.5
1600	2.6	4.3	7.9	14.6	22.1	20.6	12.4	6.9	2.1	1.0	1.0	4.6
1700	2.1	3.6	7.2	14.4	22.5	21.1	12.9	7.2	2.3	1.0	1.0	4.6
1800	1.7	2.9	6.6	14.2	22.9	21.7	13.3	7.6	2.4	1.0	1.0	4.7
1900	1.3	2.1	5.9	14.0	23.3	22.3	13.7	7.9	2.6	1.0	1.0	4.8
2000	0.9	1.4	5.3	13.9	23.7	22.9	14.1	8.3	2.7	1.0	1.0	4.9
2100	0.4	0.7	4.6	13.7	24.1	23.4	14.6	8.6	2.9	1.0	1.0	4.9
2200	0.0	0.0	4.0	13.5	24.5	24.0	15.0	9.0	3.0	1.0	1.0	5.0
												100.0

**TABLE A.5-4**  
**MADERA CANAL CLASS 1 DELIVERY PATTERN**

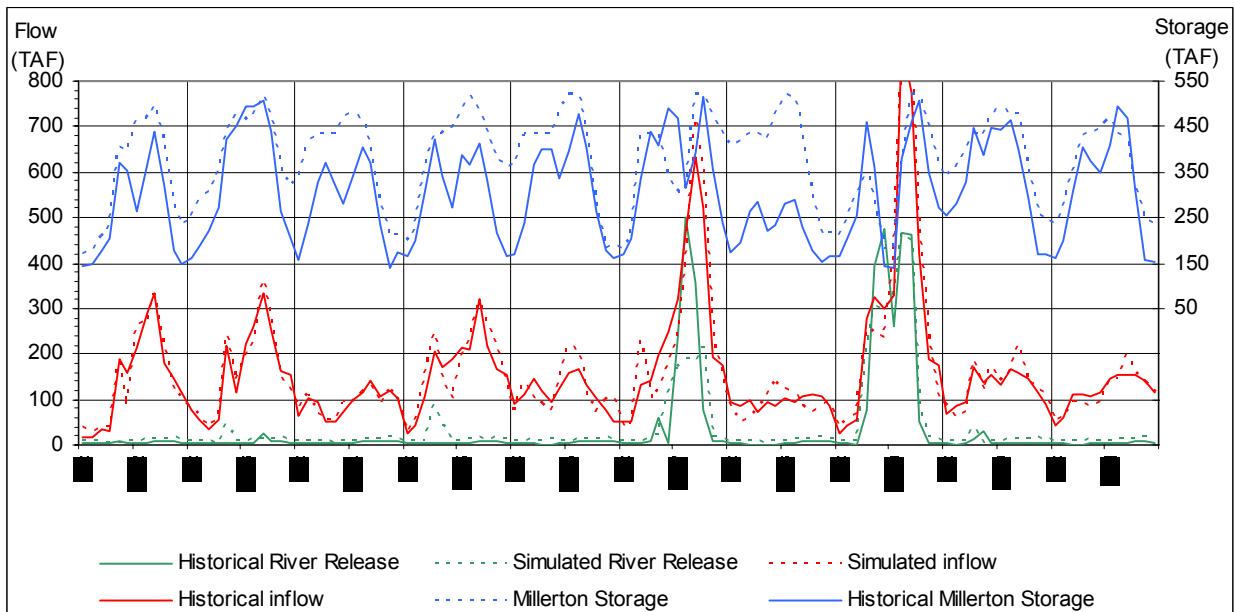
Total Delivery	Percent of annual delivery											
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
0	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
800	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
900	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
1000	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
1100	0.0	0.0	9.0	28.0	35.0	24.0	4.0	0.0	0.0	0.0	0.0	0.0
1200	0.0	0.0	0.0	24.0	30.0	30.0	14.0	1.0	1.0	0.0	0.0	0.0
1300	0.0	0.0	0.0	22.0	30.0	30.0	15.0	2.0	1.0	0.0	0.0	0.0
1400	0.0	0.0	0.0	22.0	30.0	30.0	15.0	2.0	1.0	0.0	0.0	0.0
1500	0.0	0.0	0.0	20.0	30.0	30.0	15.0	3.0	2.0	0.0	0.0	0.0
1600	0.0	0.0	0.0	18.0	30.0	30.0	15.0	5.0	2.0	0.0	0.0	0.0
1700	0.0	0.0	0.0	16.0	30.0	30.0	15.0	7.0	2.0	0.0	0.0	0.0
1800	0.0	0.0	0.0	8.0	22.0	30.0	24.0	10.0	3.0	0.0	0.0	3.0
1900	0.0	0.0	0.0	8.0	17.0	30.0	24.0	15.0	3.0	0.0	0.0	3.0
2000	0.0	0.0	0.0	8.0	17.0	30.0	24.0	15.0	3.0	0.0	0.0	3.0
2100	0.0	0.0	0.0	8.0	17.0	30.0	24.0	15.0	3.0	0.0	0.0	3.0
2200	0.0	0.0	0.0	8.0	17.0	30.0	24.0	15.0	3.0	0.0	0.0	3.0
												100.0

## Attachment A.6

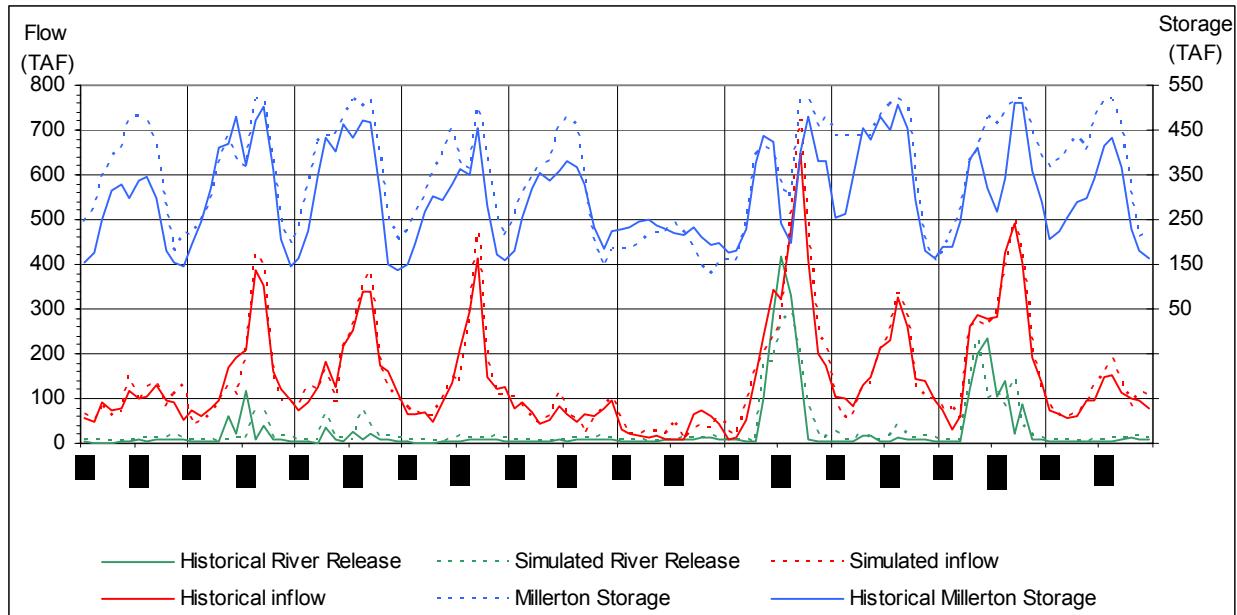
### Monthly Simulation Results



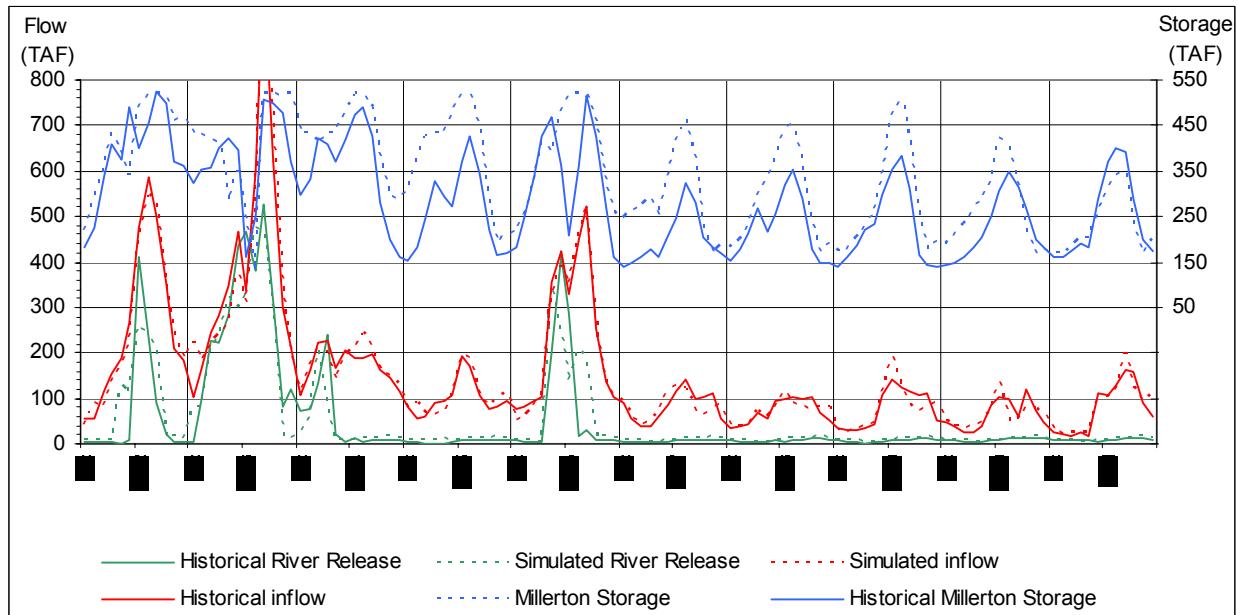
**FIGURE A.6-1. SIMULATION OF MILLERTON RESEVOIR 1952-1961**



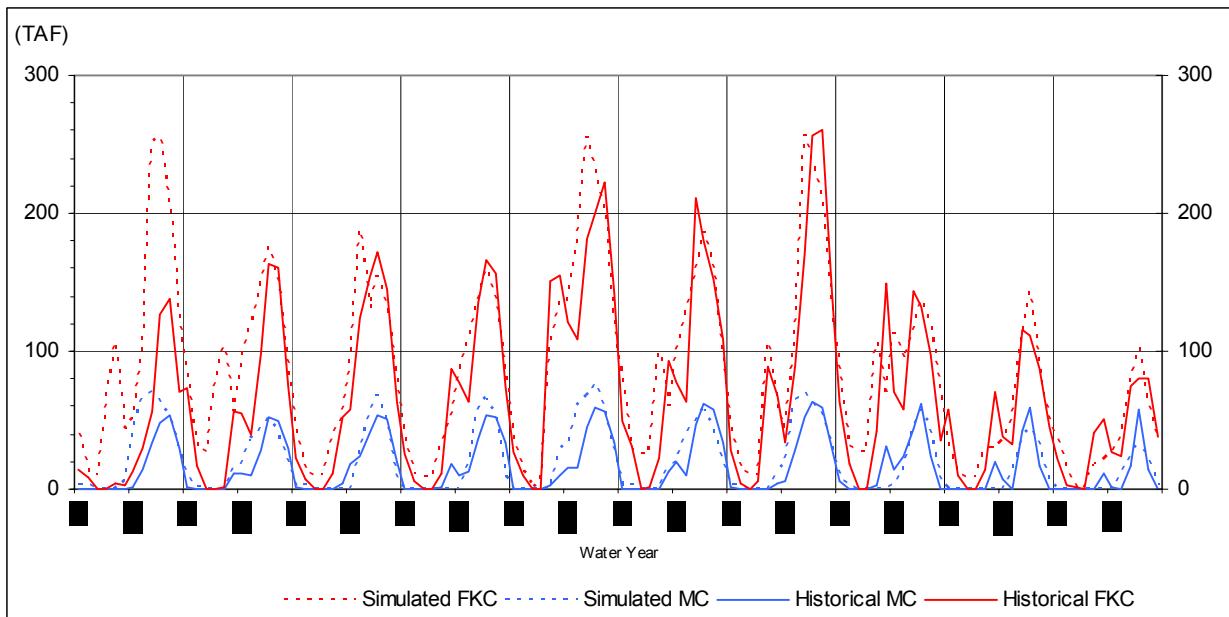
**FIGURE A.6-2. SIMULATION OF MILLERTON RESEVOIR 1962-1971**



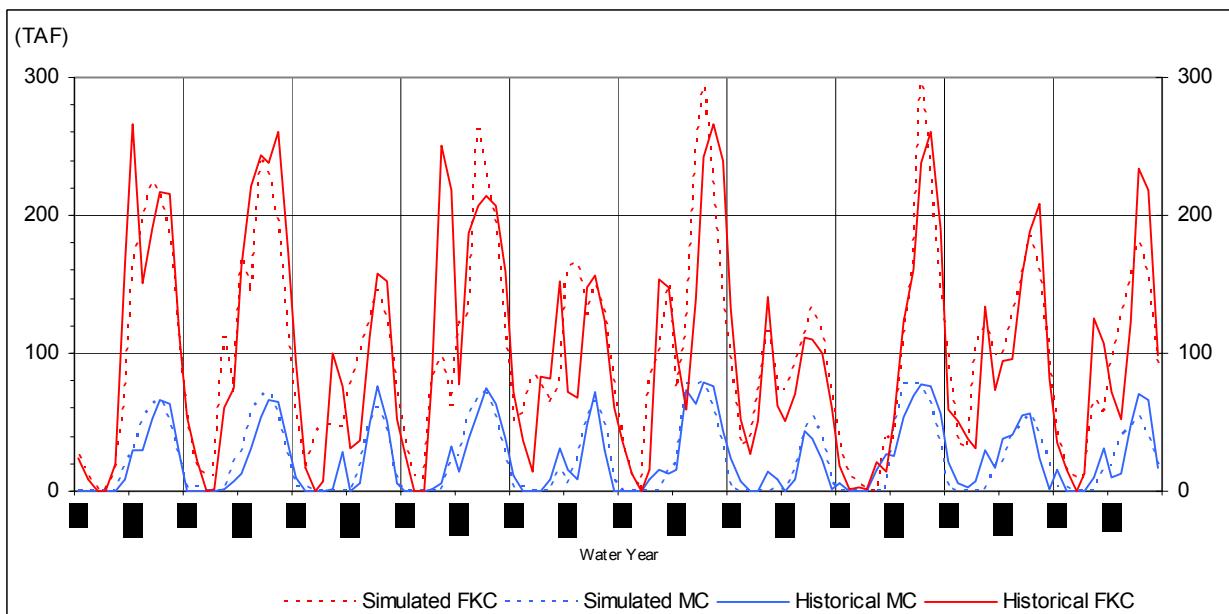
**FIGURE A.6-3. SIMULATION OF MILLERTON RESEVOIR 1972-1981**



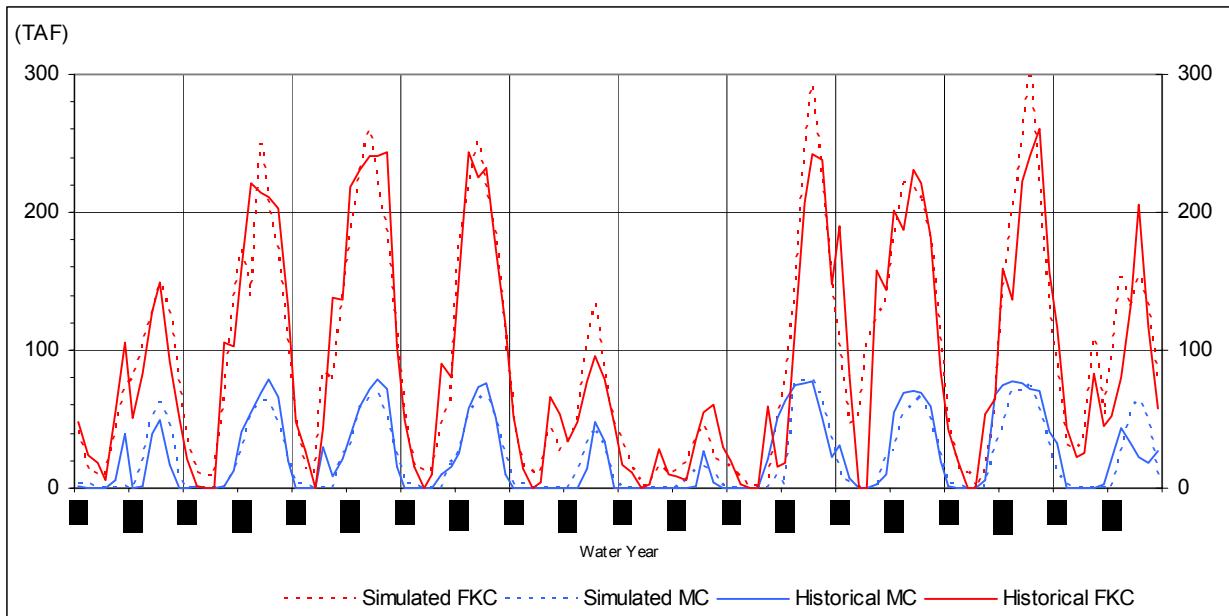
**FIGURE A.6-4. SIMULATION OF MILLERTON RESEVOIR 1982-1991**



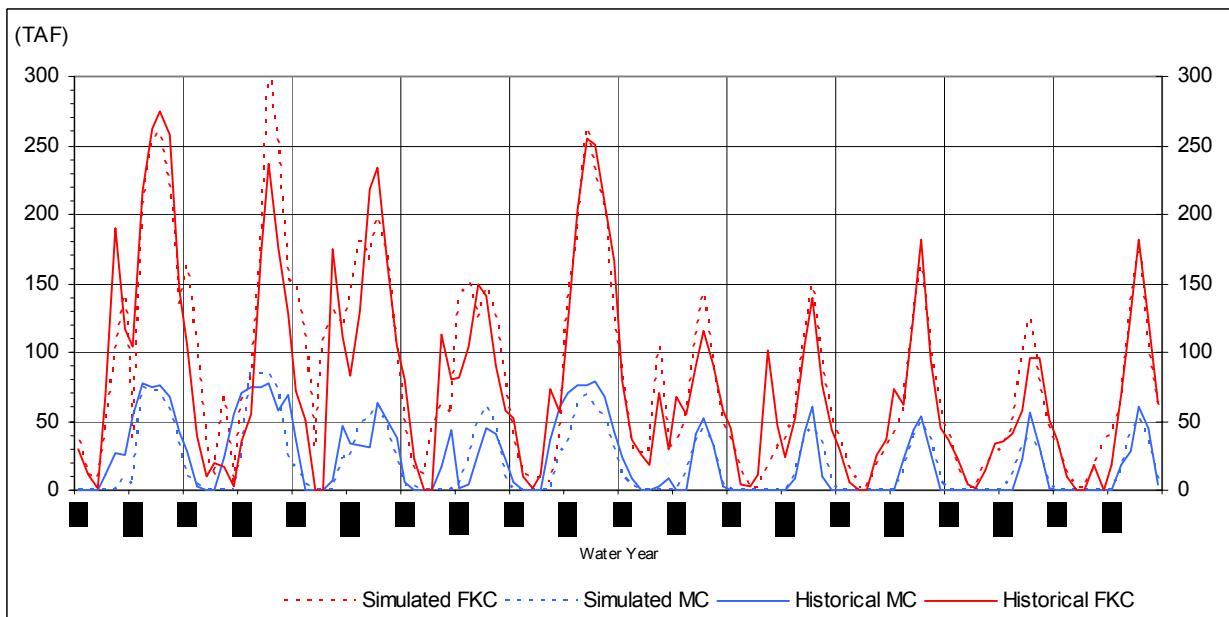
**FIGURE A.6-5. SIMULATION OF FRIANT-KERN AND MADERA CANALS 1952-1961**



**FIGURE A.6-6. SIMULATION OF FRIANT-KERN AND MADERA CANALS 1962-1971**



**FIGURE A.6-7. SIMULATION OF FRIANT-KERN AND MADERA CANALS 1972-1981**



**FIGURE A.6-8. SIMULATION OF FRIANT-KERN AND MADERA CANALS 1982-1991**

**TABLE A.6-1**  
 **MILLERTON RESERVOIR END OF MONTH STORAGE (1,000 ACRE-FEET)**

M	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1922	338	376	436	436	436	386	231	289	521	513	363	299
	1923	272	298	373	436	421	450	520	520	500	419	317	300
	1924	323	362	385	408	405	455	488	474	347	219	161	174
	1925	164	181	212	246	316	335	422	479	459	352	242	224
	1926	247	281	312	339	372	411	519	521	461	296	190	195
	1927	201	256	314	367	436	478	499	520	521	440	312	273
	1928	292	381	429	436	436	478	520	519	451	289	201	202
	1929	186	195	213	233	233	257	290	366	317	216	162	190
	1930	169	168	186	214	238	269	350	351	334	216	161	190
	1931	175	182	201	227	240	257	304	314	241	166	133	159
	1932	156	154	218	291	436	468	457	414	490	434	287	236
	1933	244	279	301	335	336	372	400	313	362	300	218	225
	1934	225	237	280	332	357	443	520	490	362	226	172	179
	1935	174	193	235	310	382	376	414	456	511	379	240	201
	1936	216	259	284	331	436	462	509	521	506	369	233	190
	1937	194	228	270	313	436	479	459	519	521	383	214	154
	1938	166	205	399	436	319	361	368	334	521	521	444	378
	1939	365	387	405	436	396	478	521	520	393	218	144	166
	1940	172	177	197	333	436	478	509	521	519	374	242	211
	1941	219	254	350	436	436	479	454	505	521	516	403	348
	1942	338	370	436	436	436	413	439	459	521	494	351	289
	1943	272	324	361	412	436	479	521	521	496	358	221	178
	1944	181	218	245	283	305	354	369	420	406	313	225	225
	1945	238	301	364	415	436	479	463	459	484	415	287	246
	1946	289	381	436	436	436	478	520	521	508	372	253	250
	1947	281	367	436	436	436	478	519	520	431	284	200	211
	1948	212	228	246	268	266	246	289	337	386	297	202	208
	1949	227	249	274	301	311	324	400	477	473	310	210	215
	1950	230	253	279	329	395	410	514	520	494	344	223	220
	1951	240	377	381	436	436	473	519	485	449	344	258	243
	1952	245	264	336	436	419	340	358	475	521	515	436	380
	1953	350	361	394	436	409	438	463	394	355	319	245	234
	1954	231	246	269	307	343	391	497	520	480	337	221	202
	1955	215	245	285	334	363	387	390	391	428	304	220	224
	1956	223	238	348	348	436	479	521	517	521	499	405	359
	1957	357	385	399	429	415	432	417	391	458	362	262	240
	1958	253	279	329	377	368	289	339	460	521	515	409	356
	1959	327	338	345	384	388	478	520	498	416	273	176	210
	1960	215	222	233	253	284	320	413	440	368	234	177	186
	1961	169	185	225	253	273	290	350	345	277	177	154	171
	1962	169	179	209	240	404	398	463	471	501	412	276	235
	1963	251	288	308	353	436	477	466	479	520	469	351	319
	1964	336	418	436	436	436	474	481	466	410	275	207	213
	1965	198	229	362	436	436	448	483	520	488	432	383	356
	1966	366	436	436	436	478	521	520	437	275	182	192	
	1967	182	209	434	436	436	337	305	311	521	521	472	431
	1968	409	419	436	436	423	478	520	516	429	295	210	217
	1969	212	249	301	348	287	183	186	369	521	521	446	363
	1970	341	360	395	436	429	479	493	476	475	352	262	243
	1971	239	273	352	428	436	446	467	435	417	320	245	237
	1972	247	276	339	387	411	478	480	472	417	267	182	218
	1973	215	245	293	373	436	386	365	519	521	382	241	198
	1974	222	327	426	436	436	474	518	504	521	384	252	206
	1975	222	266	307	353	398	456	371	362	503	387	244	212
	1976	254	311	344	371	379	461	479	461	327	192	145	183
	1977	183	185	197	217	221	224	246	219	185	144	130	157
	1978	157	157	235	395	409	404	323	298	521	521	457	482
	1979	436	436	436	436	436	479	506	521	507	338	198	160
	1980	178	229	267	380	405	479	462	493	521	521	447	388
	1981	367	386	406	436	407	475	520	519	453	296	213	223
	1982	219	287	354	436	386	341	489	521	521	515	460	468
	1983	436	432	418	412	284	353	239	130	521	521	516	520
	1984	436	436	407	436	436	478	520	519	491	377	295	288
	1985	309	374	424	436	436	478	520	519	434	284	193	213
	1986	217	253	324	416	390	479	521	521	458	317	259	
	1987	247	265	273	293	252	335	418	463	370	227	168	187
	1988	182	199	232	297	332	373	445	452	366	233	176	190
	1989	172	177	204	235	260	330	473	506	410	250	180	195
	1990	192	207	233	267	288	330	423	405	317	215	170	179
	1991	168	167	183	202	205	261	311	342	349	230	168	200
	1992	187	202	232	266	319	362	470	509	375	239	178	187
	1993	174	184	223	412	431	435	416	521	521	515	391	337
	1994	324	340	355	381	347	425	462	472	407	270	188	200
Average	247	278	321	363	377	406	437	451	447	350	259	247	
Max	436	436	436	436	479	521	521	521	521	516	520		
Min	156	154	183	202	205	183	186	130	185	144	130	154	

**TABLE A.6-2**  
**FRIANT-KERN AND MADERA CANAL DIVERSIONS (1,000 ACRE-FEET)**

Fr	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
	1922	5	4	14	75	69	150	223	248	332	293	257	151	1821
	1923	92	33	27	28	105	86	138	252	217	256	210	116	1560
	1924	47	17	11	11	42	23	28	52	115	148	92	42	628
	1925	29	12	1	1	14	54	89	137	204	242	197	91	1073
	1926	39	13	10	10	36	53	112	208	170	204	164	77	1096
	1927	34	11	8	8	79	91	198	262	315	269	220	122	1617
	1928	49	17	11	44	59	104	110	192	187	224	180	84	1263
	1929	36	12	9	9	33	30	37	67	152	195	121	54	754
	1930	38	15	1	1	18	30	36	66	151	193	120	54	724
	1931	37	15	1	1	18	16	19	35	75	96	61	28	403
	1932	20	9	1	1	20	88	209	273	305	295	242	133	1596
	1933	54	18	12	12	48	52	85	131	194	229	188	87	1110
	1934	38	12	9	9	35	27	47	58	131	169	105	48	688
	1935	33	13	1	1	16	81	200	266	306	270	221	122	1532
	1936	50	17	11	11	32	152	134	279	251	277	227	125	1564
	1937	51	18	12	12	0	63	118	204	331	291	238	131	1468
	1938	53	18	12	75	114	4	98	187	315	381	275	157	1689
	1939	93	33	30	40	117	63	154	92	176	226	139	63	1225
	1940	43	17	1	0	4	130	191	254	262	237	194	107	1441
	1941	44	16	10	43	34	151	167	172	324	333	252	140	1685
	1942	81	30	42	99	122	169	224	233	321	306	255	141	2023
	1943	82	32	26	19	139	25	125	286	259	289	236	130	1648
	1944	53	18	12	12	47	54	89	136	202	241	195	90	1149
	1945	39	12	9	9	30	96	214	286	314	303	248	136	1696
	1946	55	19	81	86	63	83	183	249	203	245	195	91	1554
	1947	39	12	33	63	74	78	82	184	169	203	164	77	1178
	1948	34	11	8	8	31	46	76	115	170	205	164	77	944
	1949	34	11	8	8	31	51	83	127	189	227	182	85	1035
	1950	37	12	9	9	34	56	92	186	199	237	192	89	1149
	1951	38	5	83	83	102	74	113	161	197	233	191	106	1385
	1952	43	15	10	55	107	50	93	167	321	320	255	149	1585
	1953	91	31	27	72	104	72	110	158	193	228	187	103	1376
	1954	43	15	10	10	37	54	89	216	186	224	180	84	1147
	1955	36	12	9	9	33	52	85	130	193	228	187	87	1061
	1956	37	12	0	5	103	165	170	242	325	308	256	142	1764
	1957	82	32	26	26	101	77	118	169	207	245	201	111	1395
	1958	45	16	11	11	107	70	64	173	329	299	262	153	1540
	1959	94	32	27	27	107	70	117	110	163	196	157	74	1175
	1960	33	11	8	8	30	29	36	65	147	188	117	53	723
	1961	37	15	1	1	18	22	26	48	106	136	85	39	531
	1962	27	11	1	1	13	86	188	248	288	283	232	128	1506
	1963	52	18	12	12	112	93	198	201	307	301	246	135	1687
	1964	55	19	42	48	49	47	77	118	174	208	168	79	1082
	1965	34	11	8	82	98	85	146	186	330	300	245	134	1660
	1966	54	60	86	78	64	94	169	191	180	218	174	81	1451
	1967	35	12	0	82	99	166	93	193	321	373	274	166	1815
	1968	93	33	36	69	117	74	73	108	157	189	152	72	1170
	1969	32	11	8	0	0	40	81	186	246	379	283	171	1436
	1970	95	34	31	104	120	118	118	168	205	243	199	110	1546
	1971	45	16	10	10	67	74	114	164	200	237	194	107	1239
	1972	44	16	10	10	39	75	79	121	179	213	173	81	1039
	1973	35	12	9	9	60	147	200	192	314	266	218	120	1582
	1974	49	17	11	85	78	163	208	285	327	287	235	129	1875
	1975	52	18	12	12	46	84	204	274	315	281	230	127	1657
	1976	51	18	12	12	46	27	33	61	137	175	109	49	730
	1977	34	14	1	1	17	11	13	24	49	62	32	19	276
	1978	14	7	1	1	0	62	76	216	320	372	285	175	1530
	1979	110	50	51	105	124	158	204	275	279	275	226	124	1981
	1980	50	17	12	0	13	87	186	269	319	380	264	157	1755
	1981	96	33	28	34	110	53	96	177	185	220	179	84	1294
	1982	36	12	9	43	100	153	41	278	325	333	274	162	1766
	1983	173	107	25	10	68	5	90	164	257	393	316	174	1782
	1984	163	112	32	107	132	142	162	230	220	260	213	118	1891
	1985	48	17	11	44	61	56	144	173	176	210	170	80	1189
	1986	35	11	8	8	6	63	169	249	332	288	255	149	1573
	1987	91	33	27	27	104	29	36	65	147	189	117	53	918
	1988	37	15	1	1	18	30	37	67	152	195	120	54	726
	1989	38	15	1	1	18	33	40	73	166	213	131	59	788
	1990	41	16	1	1	20	26	31	57	128	164	102	46	632
	1991	32	13	1	1	16	35	42	77	176	226	139	63	821
	1992	43	17	1	1	21	30	36	66	149	191	119	54	728
	1993	37	15	1	1	85	164	169	248	330	308	257	142	1757
	1994	83	32	26	26	101	42	70	106	155	187	150	71	1047
Average		53	21	16	28	59	74	112	170	225	248	193	102	1300
Max		173	112	86	107	139	169	224	286	332	393	316	175	2023
Min		5	4	0	0	0	4	13	24	49	62	32	19	276

**TABLE A.6-3**  
**FRIANT RELEASE TO SAN JOAQUIN RIVER (1,000 ACRE-FEET)**

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1922	10	7	7	15	45	7	112	98	92	14	16	13	437
1923	10	7	7	5	5	7	9	11	13	14	16	13	117
1924	10	7	7	5	5	7	9	11	13	14	16	13	117
1925	10	7	7	5	5	7	9	11	13	14	16	13	117
1926	10	7	7	5	5	7	9	29	13	14	16	13	135
1927	10	7	7	5	9	7	9	11	57	14	16	13	165
1928	10	7	7	7	12	7	9	11	13	14	16	13	126
1929	10	7	7	5	5	7	9	11	13	14	16	13	117
1930	10	7	7	5	5	7	9	11	13	14	16	13	117
1931	10	7	7	5	5	7	9	11	13	14	16	13	117
1932	10	7	7	5	6	7	9	11	13	14	16	13	118
1933	10	7	7	5	5	7	9	11	13	14	16	13	117
1934	10	7	7	5	5	7	9	11	13	14	16	13	117
1935	10	7	7	5	67	7	83	57	13	14	16	13	299
1937	10	7	7	5	112	124	169	174	63	14	16	13	715
1938	10	7	7	9	227	281	315	439	358	47	16	13	1729
1939	10	7	7	5	5	7	20	11	13	14	16	13	128
1940	10	7	7	5	26	7	9	65	13	14	16	13	191
1941	10	7	7	7	164	17	103	187	213	14	16	13	760
1942	10	7	8	49	13	7	15	11	103	14	16	13	266
1943	10	7	7	83	15	186	111	54	13	14	16	13	529
1944	10	7	7	5	5	7	9	11	13	14	16	13	117
1945	10	7	7	5	191	7	16	11	13	14	16	13	310
1946	10	7	12	21	12	7	9	52	13	14	16	13	187
1947	10	7	8	9	8	7	9	11	13	14	16	13	125
1948	10	7	7	5	5	7	9	11	13	14	16	13	117
1949	10	7	7	5	5	7	9	11	13	14	16	13	117
1950	10	7	7	5	5	7	9	11	13	14	16	13	117
1951	10	48	225	78	32	7	9	11	13	14	16	13	477
1952	10	7	7	8	23	179	175	284	221	14	16	13	957
1953	10	7	7	8	5	7	9	11	13	14	16	13	120
1954	10	7	7	5	5	7	9	11	13	14	16	13	117
1955	10	7	7	5	5	7	9	11	13	14	16	13	117
1956	10	7	208	278	32	17	38	85	172	14	16	13	891
1957	10	7	7	5	5	7	9	11	13	14	16	13	117
1958	10	7	7	5	26	179	168	244	168	14	16	13	857
1959	10	7	7	5	5	7	9	11	13	14	16	13	117
1960	10	7	7	5	5	7	9	11	13	14	16	13	117
1961	10	7	7	5	5	7	9	11	13	14	16	13	117
1962	10	7	7	5	5	7	9	11	13	14	16	13	117
1963	10	7	7	5	47	7	9	11	13	14	16	13	159
1964	10	7	9	7	5	7	9	11	13	14	16	13	121
1965	10	7	7	91	42	7	9	11	17	14	16	13	245
1966	10	10	14	9	12	7	10	11	13	14	16	13	140
1967	10	7	7	16	21	114	170	189	186	217	16	13	966
1968	10	7	7	7	5	7	9	11	13	14	16	13	120
1969	10	7	7	210	306	300	325	464	447	81	16	13	2188
1970	10	7	7	41	5	7	9	11	13	14	16	13	153
1971	10	7	7	5	12	7	9	11	13	14	16	13	124
1972	10	7	7	5	5	7	9	11	13	14	16	13	117
1973	10	7	7	5	7	12	9	75	72	14	16	13	248
1974	10	7	7	69	13	14	9	80	39	14	16	13	292
1975	10	7	7	5	5	7	15	11	13	14	16	13	124
1976	10	7	7	5	5	7	9	11	13	14	16	13	117
1977	10	7	7	5	5	7	9	11	13	14	16	13	117
1978	10	7	7	5	183	183	267	298	178	87	16	13	1253
1979	24	8	8	25	10	7	17	44	13	14	16	13	198
1980	10	7	7	148	235	98	118	82	148	40	16	13	923
1981	10	7	7	5	5	7	9	11	13	14	16	13	117
1982	10	7	7	7	126	110	262	234	201	14	16	13	1008
1983	82	81	210	236	324	301	335	474	469	288	16	13	2829
1984	25	63	205	63	9	7	9	11	13	14	16	13	447
1985	10	7	7	7	12	7	9	11	13	14	16	13	126
1986	10	7	7	5	345	240	136	211	182	14	16	13	1186
1987	10	7	7	5	5	7	9	11	13	14	16	13	117
1988	10	7	7	5	5	7	9	11	13	14	16	13	117
1989	10	7	7	5	5	7	9	11	13	14	16	13	117
1990	10	7	7	5	5	7	9	11	13	14	16	13	117
1991	10	7	7	5	5	7	9	11	13	14	16	13	117
1992	10	7	7	5	5	7	9	11	13	14	16	13	117
1993	10	7	7	5	27	15	96	116	183	14	16	13	510
1994	10	7	7	5	5	7	9	11	13	14	16	13	117
Average	11	10	18	24	40	38	48	63	58	24	16	13	363
Max	82	81	225	278	345	301	335	474	469	288	16	13	2829
Min	10	7	7	5	5	7	9	11	13	14	16	13	117

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